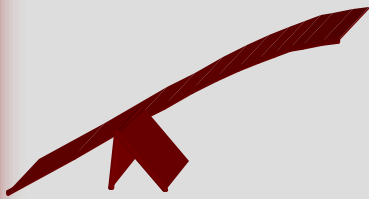# Evolutionary Differences Between CMM for Software and the CMMI

Kasse Initiatives

Carnegie Mellon
Software Engineering Institute

CMMI Technology Conference
November 2001
Denver, Colorado

Welcome

WelKom

Huan Yín

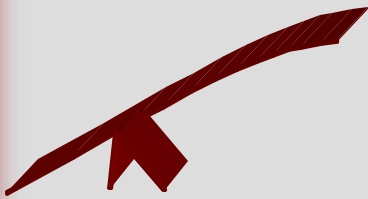Bienvenido

Bienvenue

Wilkommen

? ? ? ? S ? ? ?S? ? ?

Bienvenuto

Välkommen

Tervetuloa

Witamy

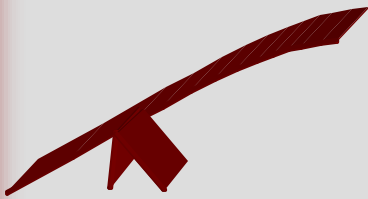# Presenters

↵ Tim Kasse – Kasse Initiatives LLC

  ≥ Manager and Principal Consultant

  ≥ SEI Visiting Scientist

 ≥ Institute for Systems Science / National University of Singapore Visiting Fellow

↵ Mike Phillips – Software Engineering Institute

  ≥ Project Manager - CMMI Product Development Team

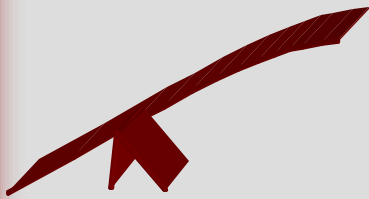# Agenda

↵ An Integrated Approach

↵ The CMM Explosion

↵ The CMMI Project

↵ Model Representations: Staged and Continuous

↵ Integrated Institutionalization Practices

↵ The Process Areas

↵ Starting the Transition
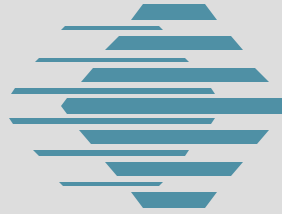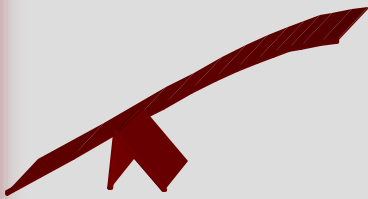
Adapting an An Integrated Approach
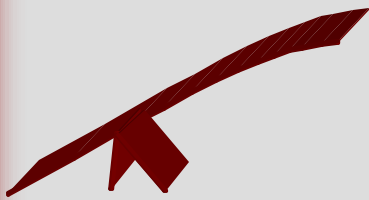
Why an Integrated Approach?

↵ Software Engineering is not considered an engineering discipline throughout the world when compared to electrical engineering, mechanical engineering, and civil engineering

↵ Software Engineering's brief history has been filled with problems:

- ≥ Cost overruns
- ≥ Schedule slippage
- ≥ Poor performance compared to specification
- ≥ Unsatisfied customers
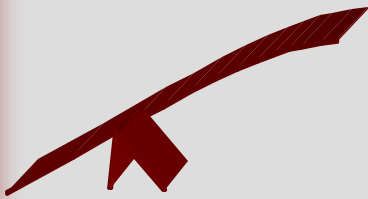
Why an Integrated Approach? - 2

↵ Software is becoming such a large factor in the systems that are being built today that it is virtually impossible to logically separate the two disciplines

↵ Demands for software-intensive systems have been growing steadily in the government and commercial marketplaces

↵ Some organizations have developed "product lifecycles" that include systems, software, hardware, marketing, manufacturing, etc.

≥ Motorola Microsystems - 1985

Why an Integrated Approach? - 3

↵ AT&T realized an increase in productivity and product quality by creating integrated teams that forced marketing, systems, software, and hardware representatives to work together and be accountable as a team for the delivery of the product – 1990

↵ Integrating Systems and Software engineering activities enabled Ford Aerospace to regain its competitive position in the command and control market place and reach CMM Level 3 at the same time – 1989 - 1992
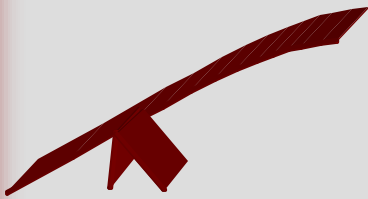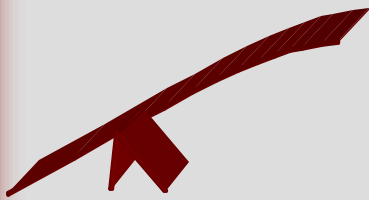
The CMM Explosion
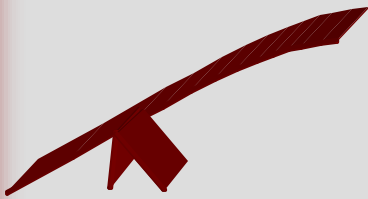
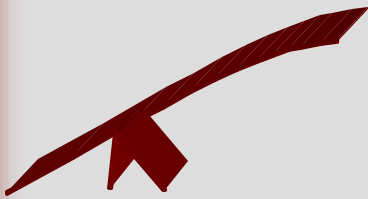# The CMM Explosion

↵ The first CMM (CMM v1.0) was developed for software and released in August 1990

↵ Based on this success and the demand from other interests CMMs were developed for other disciplines and functions

- ≥ Systems Engineering
- ≥ People
- ≥ Integrated Product Development
- ≥ Software Acquisition
- ≥ Software Quality Assurance
- ≥ Measurement
- ≥ Others…….

The CMM Explosion - 2
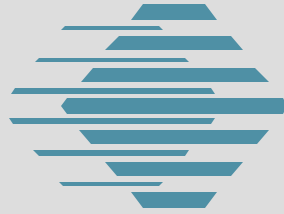
↵ While organizations found these various CMMs to be useful they also found them to be:

- ≥ Overlapping
- ≥ Contradicting
- ≥ Lacking clean, understandable interfaces
- ≥ Lacking standardization
- ≥ Displaying different levels of detail

↵ In addition, many organizations also had to deal with ISO 9001 Audits or TickIT audits based on ISO 9000-3

↵ This resulted in expensive, confusing and conflicting process improvement programs

The Frameworks Quagmire

PSP

People CMM

SA-CMM

FAA-iCMM

SW-CMM

SDCCR

SDCE

SCE

ISO 15504* (SPICE)

CMMI*

IPD-CMM*

SE-CMM

SSE-CMM

SECM* (EIA/IS 731)

SECAM

IEEE 1220

EIA/IS 632

MIL-STD -499B*

DOD IPPD

AF IPD Guide

IEEE Stds. 730,828 829, 830,1012,1016 1028,1058,1063

Trillium

Baldrige

EQA

DO-178B

TickIT

Q9000

ISO 10011

ISO 9000 Series

EIA 632*

ISO 15288*

MIL-Q -9858

NATO AQAP1,4,9

BS 5750

MIL-STD-1679

DOD-STD- 2168

DOD-STD -2167A

DOD-STD -7935A

MIL-STD- 498

EIA/IEEE J-STD-016

ISO/IEC 12207

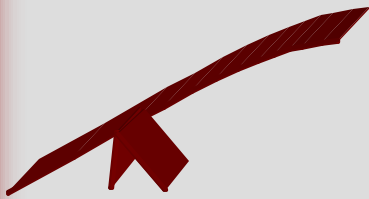IEEE 1074

IEEE/EIA 12207

* Not yet released

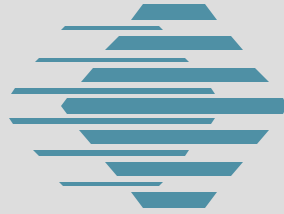Also see **www.software.org/quagmire**

Courtesy Sarah Sheard, SPC
quag14d: 5 June 1998
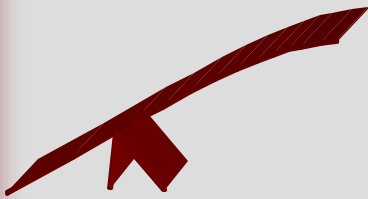
The CMMI Project

The CMMI Project

↵ The CMM Integration Project was formed to:

≥ Establish a framework to integrate current and future models

≥ Build an initial set of integrated models

↵ The source models that served as the basis for the CMMI include:

≥ CMM for Software v2.0 Draft C
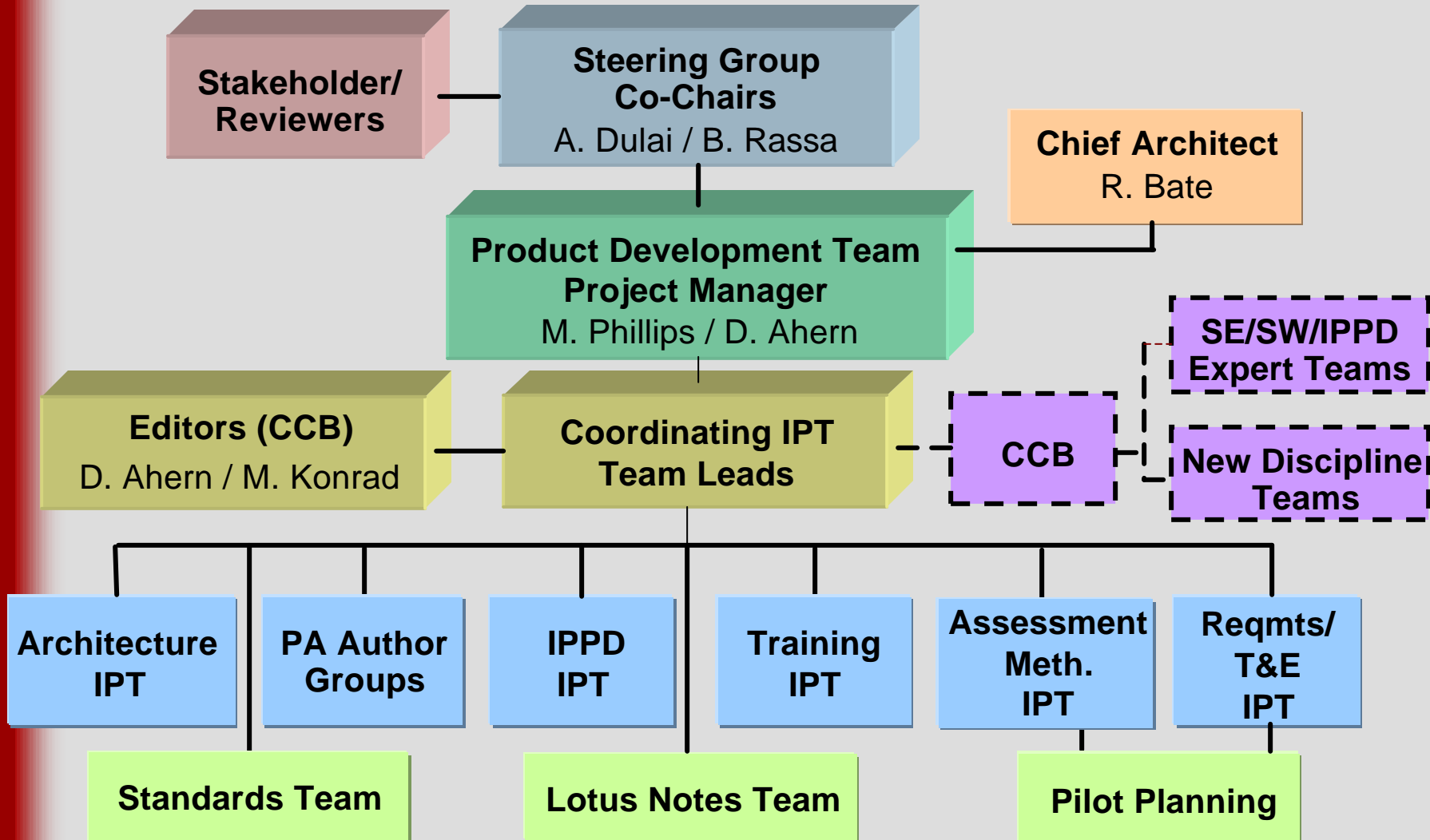
≥ EIA – 731 Systems Engineering
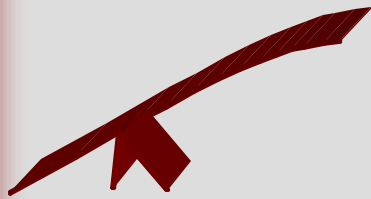
≥ IPD CMM (IPD) v0.98a
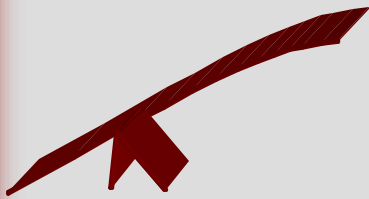
The CMMI Project

↵ Sponsored by the DOD and the National Defense Industrial Association (NDIA)

↵ Collaborative endeavor

- ≥ Industry
- ≥ Government
- ≥ Software Engineering Institute (SEI)

↵ Over 100 people involved

CMM Integration Project

Stakeholder/ Reviewers

Steering Group Co-Chairs
A. Dulai / B. Rassa

Chief Architect
R. Bate

Product Development Team Project Manager
M. Phillips / D. Ahern

SE/SW/IPPD Expert Teams

Editors (CCB)
D. Ahern / M. Konrad

Coordinating IPT Team Leads

CCB

New Discipline Teams

Architecture IPT

PA Author Groups

IPPD IPT

Training IPT

Assessment Meth. IPT

Reqmts/ T&E IPT

Standards Team

Lotus Notes Team

Pilot Planning
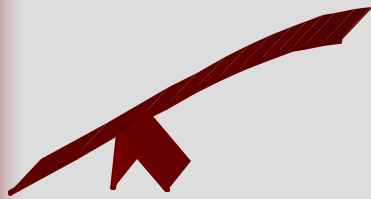
IPT = integrated product team

The CMMI Development Team

- U.S. Army, Navy, Air Force
- Federal Aviation Administration
- National Security Agency
- Software Engineering Institute
- ADP, Inc.
- AT&T Labs
- BAE
- Boeing
- Computer Sciences Corporation
- EER Systems
- Ericsson Canada
- Ernst and Young
- General Dynamics
- Harris Corporation

- Honeywell
- KPMG
- Litton
- Lockheed Martin
- Motorola
- Northrop Grumman
- Pacific Bell
- Q-Labs
- Raytheon
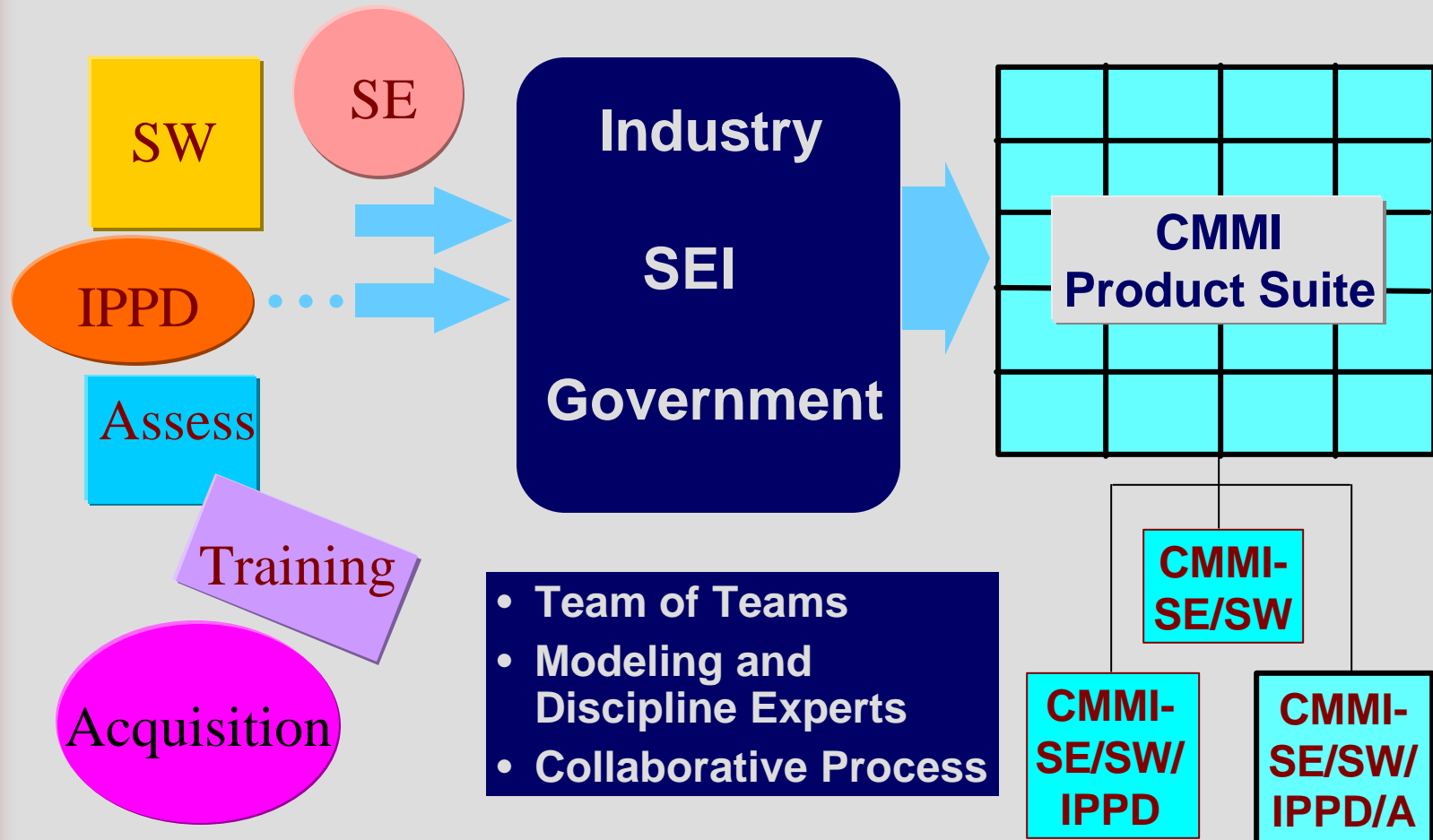- Rockwell Collins
- Sverdrup Corporation
- Thomson CSF
- TRW
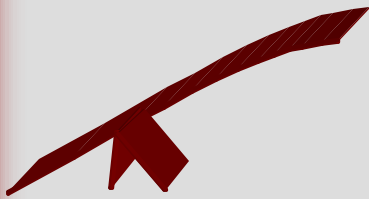
CMMI Design Goals
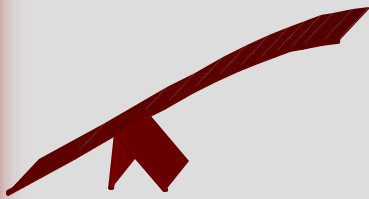
↵ Integrate the source models, eliminate inconsistencies, reduce duplication

↵ Reduce the cost of implementing model-based process improvement

↵ Increase clarity and understanding

≥ Common terminology

≥ Consistent style

≥ Uniform construction rules

≥ Common components

↵ Assure consistency with ISO 15504

↵ Be sensitive to impact on legacy efforts

The CMMI Product Line Approach

SW

SE

IPPD

Assess

Training

Acquisition

Industry

SEI

Government

- **Team of Teams**
- **Modeling and Discipline Experts**
- **Collaborative Process**

CMMI Product Suite

CMMI-SE/SW

CMMI-SE/SW/IPPD

CMMI-SE/SW/IPPD/A

CMMI Schedule

↵ December 4, 2000 Released latest published models

   ≥ CMMI-SE/SW v1.02

   ≥ CMMI-SE/SW/IPPD v1.02

↵ December 2000 Released CMMI-SE/SW/IPPD/A for initial piloting

↵ Winter 2001 Publish models V1.1

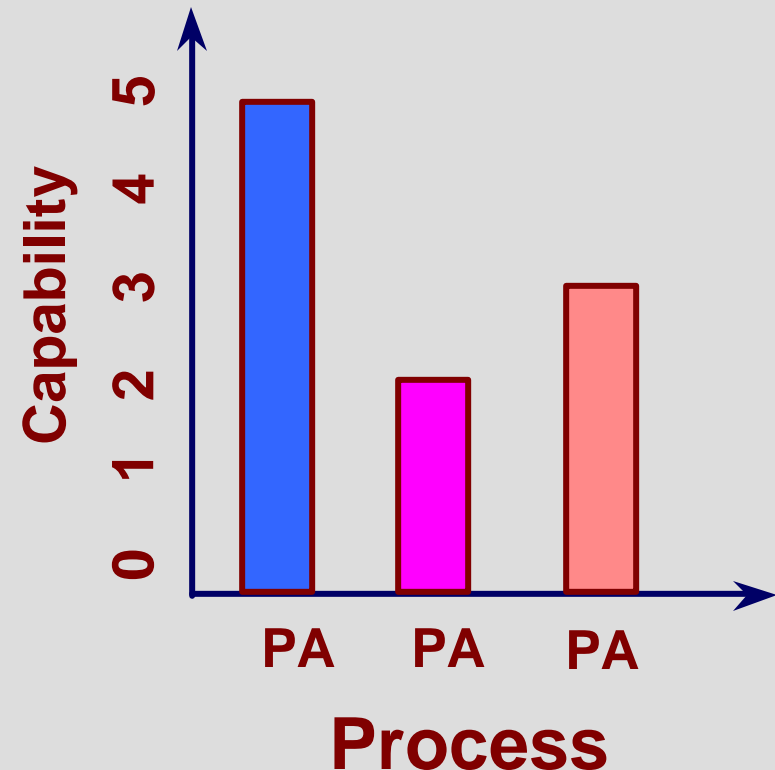↵ Fall 2003 Complete sunset period for precursor models
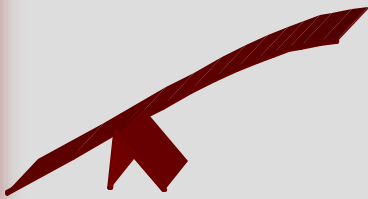
CMMI Model Representations
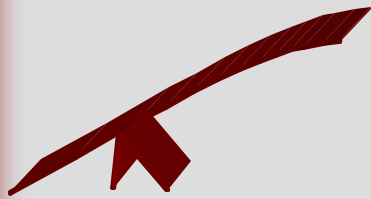
CMMI Model Representations

Staged

ML5
ML4
ML3
ML2
ML 1

Organization

Continuous

Capability

5
4
3
2
1
0

PA   PA   PA
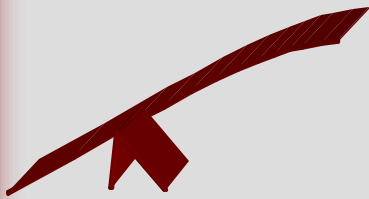
Process

CMMI Model Representations - 2

↵ CMMI models support each approach with a representation
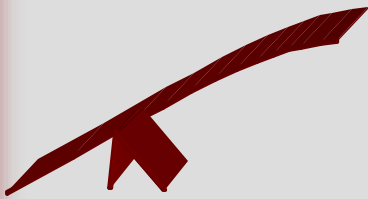
≥ Continuous Representation

↑ Designed to best support the process area capability improvement approach

↑ Uses six capability levels, capability profiles, target staging and equivalent staging as organizing principles for the model components

≥ Staged Representation

↑ Designed to best support the organizational maturity improvement approach
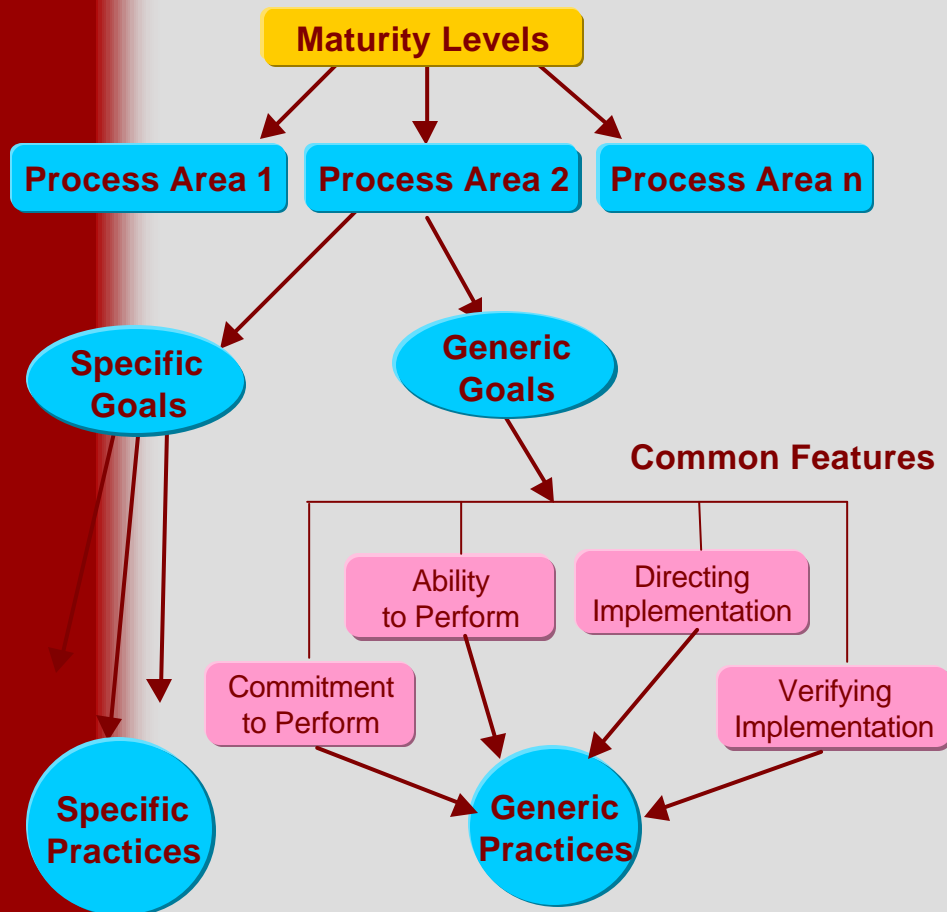
↑ Organizes the process area into five maturity levels to support and guide process improvement
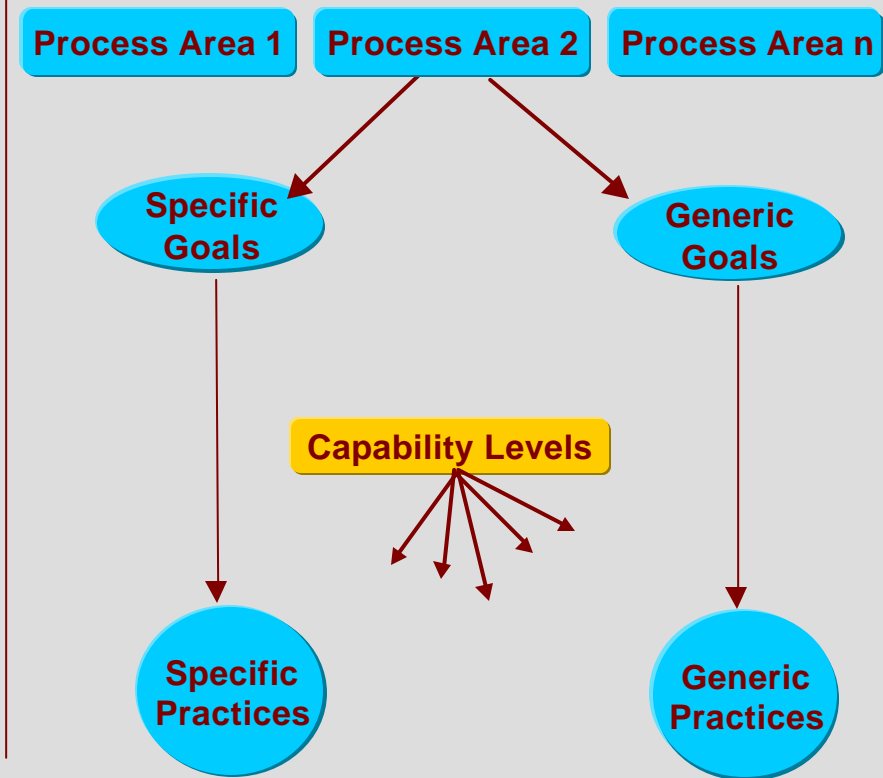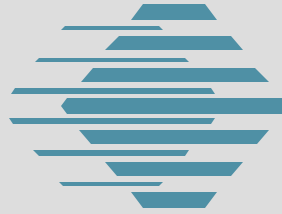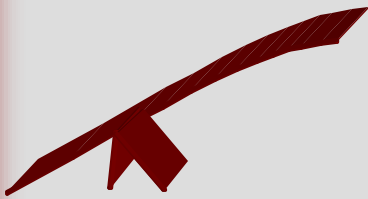
CMMI Model Structure

Staged

Maturity Levels

Process Area 1   **Process Area 2**   **Process Area n**

Specific Goals

Generic Goals

Common Features

Ability to Perform

Directing Implementation

Commitment to Perform

Verifying Implementation

Specific Practices

Generic Practices

Continuous

Process Area 1   **Process Area 2**   **Process Area n**

Specific Goals

Generic Goals

Capability Levels

Specific Practices

Generic Practices

© 2001 Kasse Initiatives, LLC

Continuous Representation

CMMI-SE/SW/IPPD/A Continuous

CMMI

Process Management

- Organizational Process Focus
- Organizational Process Definition
- Organizational Training
- Organizational Process Performance
- Organizational Innovation and Deployment

Project Management

- Project Planning
- Project Monitoring and Control
- Supplier Agreement Mgmt.
- Integrated Project Mgmt.
- Risk Management
- Quantitative Project Mgmt.

Engineering

- Requirements Management
- Requirements Development
- Technical Solution
- Product Integration
- Verification
- Validation

Support

- Configuration Mgmt.
- Process and Product Quality Assurance
- Measurement & Analysis
- Decision Analysis and Resolution
- Causal Analysis and Resolution

IPPD

- Organizational Environment for Integration
- Integrated Team

Acquisition

- Supplier Selection and Monitoring
- Integrated Supplier Management
- Quantitative Supplier Management

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Capability Levels

↵ Capability levels of the continuous representation focus on maturing the organization's ability to perform, control, and improve its performance in a process area

↵ Capability levels provide a recommended order for approaching process improvement within each process area

↵ A capability level consists of related specific and generic practices for a process area that, when performed, increase the capability of the organization in that process area and enhance the organization's overall process area capability
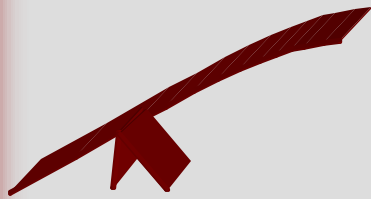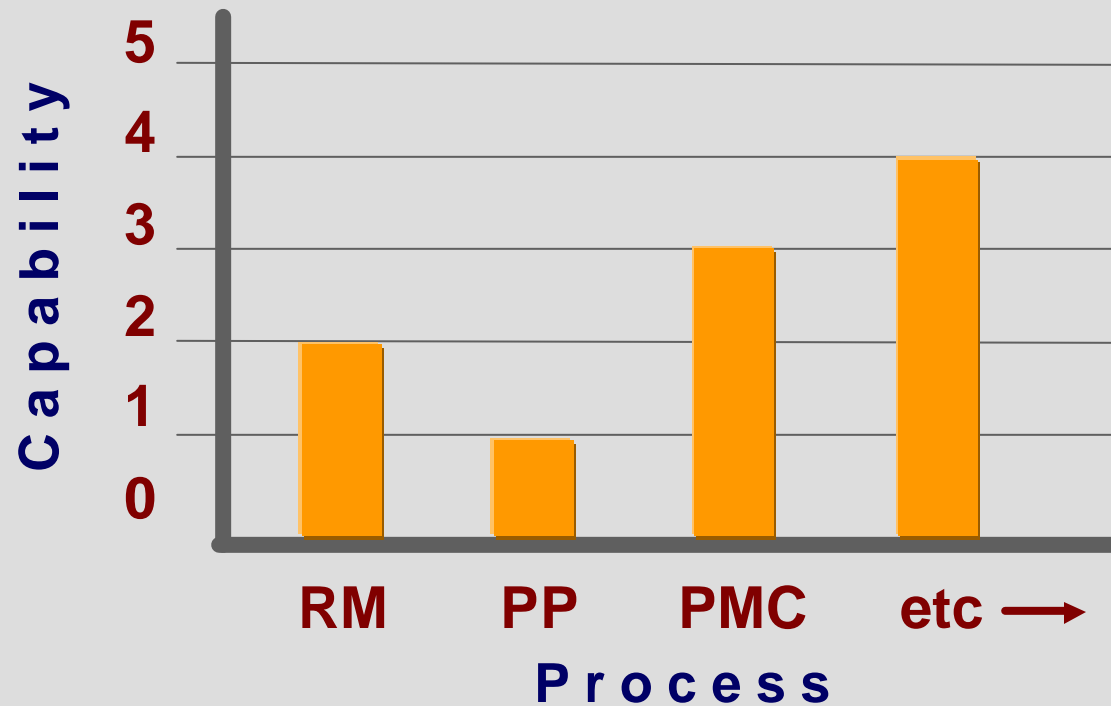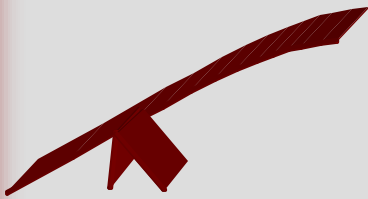
Capability Levels - 2

5 Optimizing

4 Quantitatively Managed

3 Defined

2 Managed

1 Performed

0 Incomplete
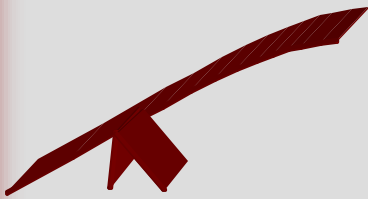
Capability Level Profile - Continuous

Bar chart with vertical axis labeled **Capability** with values 0, 1, 2, 3, 4, 5 and horizontal axis labeled **Process** with categories: RM (2), PP (1), PMC (3), etc →

Staged Representation

CMMI-SE/SW/IPPD/A Staged

Focus

Continuous Process Improvement (2 PAs)

Quantitative Management (2 PAs)

Process Standardization (11 PAs)
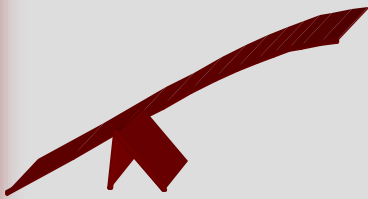
Basic Project Management (7 PAs)

Optimizing (5)
- •Organizational Innovation and Deployment (OID)
- •Causal Analysis and Resolution (CAR)

Quantitatively Managed (4)
- •Organizational Process Performance (OPP)
- •Quantitative Project Management (QPM)
- •Quantitative Supplier Management (QSM)

Defined (3)
- •Requirements Development (RD)
- •Technical Solution (TS)
- •Product Integration (PI)
- •Verification (VER)
- •Validation (VAL)
- •Organizational Process Focus (OPF)
- •Organizational Process Definition (OPD)
- •Organization Training (OT)
- •Integrated Project Management (IPM)   *
- •Risk Management(RSKM)
- •Decision Analysis and Resolution (DAR)
- •Organization Environment for Integration (OEI)
- •Integrated Team (IT)
- •Integrated Supplier Management (ISM)

Managed (2)
- •Requirements Management (REQM)
- •Project Planning (PP)
- •Project Monitoring and Control (PMC)
- •Supplier Agreement Management (SAM)
- •Measurement and Analysis (M&A)
- •Process and Product Quality Assurance (PPQA)
- •Configuration Management (CM)
- • Supplier Selection and Monitoring (SSM)

Initial (1)

Ad hoc, chaotic processes

* Additional PA goals and activities added for IPPD

Maturity Levels

↵ The maturity level of an organization provides a way to predict the future performance of an organization within a given discipline or set of disciplines

↵ The maturity level of an organization is a defined evolutionary plateau of process improvement

↵ Achieving each maturity level results in an increase in the process capability of the organization
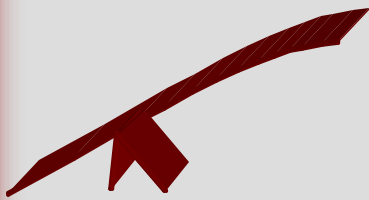
Maturity Levels - 2
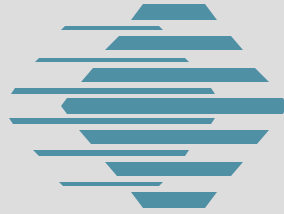
↵ Maturity levels are measured by the achievement of the specific and generic goals that apply to a predefined set of process areas
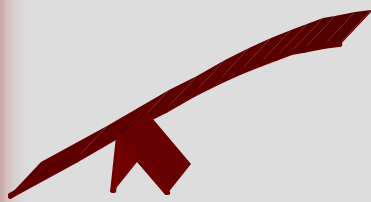
Process Area Profile Staged

Maturity Level: 1

Optimizing
- ● Causal analysis and resolution
- ● Organizational innovation & deployment

Quantitatively Managed
- ● Quantitative project management
- ● Organizational process performance

Defined
- ● Decision analysis & resolution
- ○ Risk management
- ○ Integrated product management
- ● Organizational training
- ● Organization process definition
- ● Organization process focus
- ● Validation
- ● Verification
- ● Product Integration
- ● Technical solution
- ● Requirements development

Managed
- ● Configuration management
- ● Process & product quality assurance
- ● Measurement & analysis
- ● Supplier agreement management
- ○ Project monitoring and control
- ○ Project planning
- ○ Requirements management

Legend:
- ● fully satisfied
- ○ not satisfied
- na not applicable
- X not rated
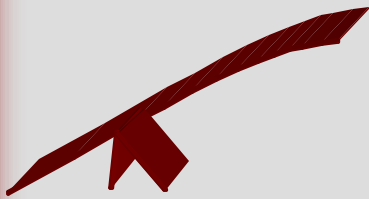
CMMI Process Area Contents

↵ Purpose

↵ Introductory Notes

↵ Goals: Specific and Generic

↵ Generic Practices

↵ Specific Practices

↵ Notes

↵ Work Products

↵ Subpractices

↵ Amplifications

↵ Elaborations
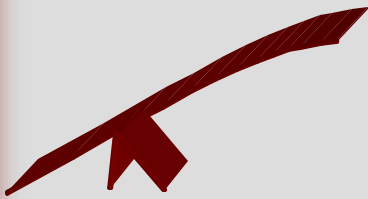
Goals

↵ **Specific** Goals

 ≥ Specific goals apply to only one process area and address the unique characteristics that describe what must be implemented to satisfy the purpose of the process area

↵ **Generic** Goals

 ≥ Generic goals apply to more than one process area

 ≥ Achievement of each of these goals relative to a process area signifies improved control in performing the process

 ≥ Achievement of each of these goals in relationship to each process area enables the institutionalization that will ensure the process is repeatable and lasting
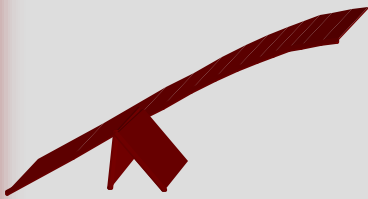
Practices
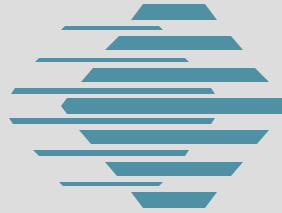
↵ Specific Practices

> ≥ A specific practice is an activity that is considered important in achieving the specific goal that it is mapped to within a process area

↵ Generic Practices

> ≥ Generic practices are practices that apply to any process area because in principle, they can improve the performance and control of any process
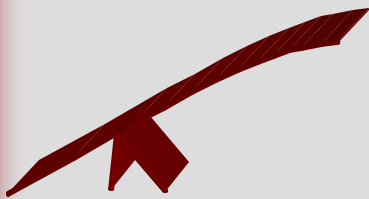
Informative Material

↳ Subpractices are suggested courses of action that correspond to practices and provide additional insight into the practices

↳ Amplifications contain information that is relevant to a particular discipline and is associated with specific practices

↳ Generic practice elaborations are model components that explain how to apply a generic practice in the context of the process area

↳ Typical work products provides examples of methods, tools, techniques, etc. that may be used to support the implementation of a practice
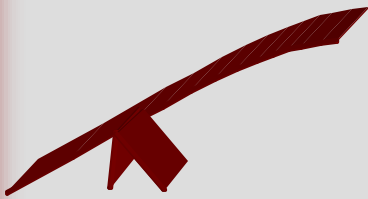
Integrated (Institutionalization) Practices for CMMI Process Areas
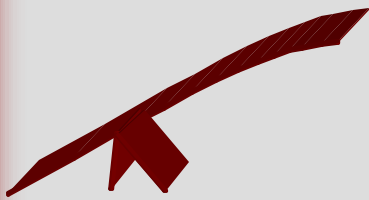
CMMI Staged Representation Common Features
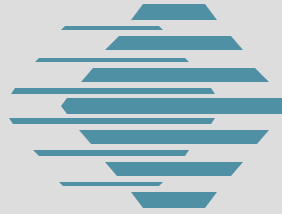
↵ Common features are predefined attributes that signify whether the implementation and institutionalization of a process area are effective, repeatable, and lasting

↵ Four Common Features

≥ Commitment to perform

≥ Ability to perform
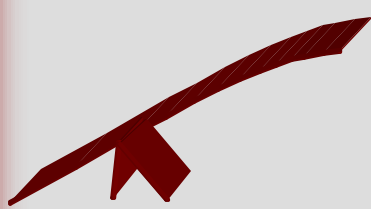
≥ Directing implementation

≥ Verifying implementation
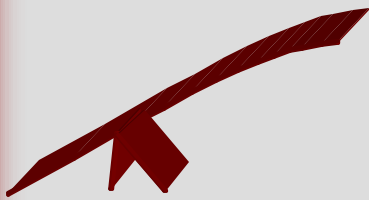
CMMI Staged Representation Common Features - 2

↵ Implementation

≥ Specific Practices

↵ Institutionalization (Generic Practices)

≥ Commitment to perform

≥ Ability to perform

≥ Directing implementation

≥ Verifying implementation

CMMI Continuous Representation Generic Practices – CL2

↵ Establish an Organizational Policy

↵ Plan the Process

↵ Provide Adequate Resources

↵ Assign Responsibility and Authority

↵ Train People To Perform

↵ Configuration Control of Process Work Products

↵ Identify and Involve Relevant Stakeholders

↵ Perform Monitor and Control the Process

↵ Objectively Verify Adherence To The Process

↵ Review Status with Higher-Level Management
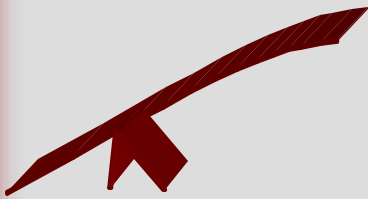
Institutionalization Mapping

Staged

Continuous

Commitment to Perform

Ability to Perform

Directing Implementation

Verifying Implementation

GP 2.1: Establish an Organizational Policy

GP 2.2: Plan the Process

GP 2.3: Provide Resources

GP 2.4: Assign Responsibility

GP 2.5: Train people

GP 2.6: Manage Configurations

GP2.7: Identify and Involve Relevant Stakeholders

GP 2.8: Monitor and Control the process

GP 2.9: Objectively Evaluate Adherence

GP 2.10: Review Status with Higher-Level Management

Managed Level (2)
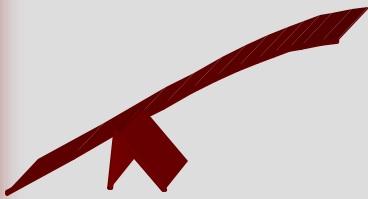
Continuous Representation
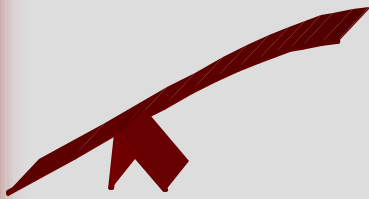
Capability Level 0

↵ Capability Level 0 deals with Incomplete processes

↵ An incomplete process is a process that is either not performed or only performed partially

≥ One or more specific goals of the process are not performed
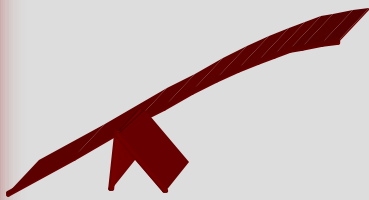
Capability Level 1

↵ Capability Level 1 deals with Performed processes

↵ A Performed process supports and enables the work needed to produce identified output work products using identified input work products

↵ The process performance may not be stable and may not meet specific objectives such as quality, cost, and schedule, but useful work can be done

↵ A critical distinction between an incomplete process and a performed process is that a performed process satisfies all of the specific goals of the process area
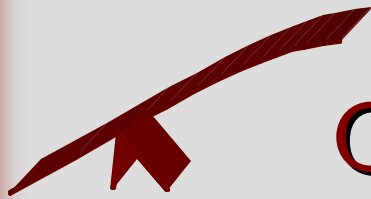
Capability Level 1 - 2

↳ GP 1.1 Identify Work Scope

- ≥ Identify the scope of the work to be performed and work products to be produced and communicate this information to those performing the work

- ≥ The purpose of this practice is to ensure that the people doing the work have a common understanding of the work to be performed and work products to be produced
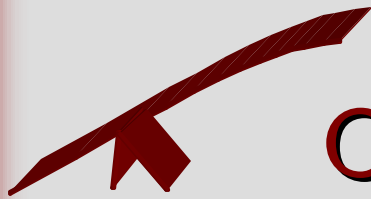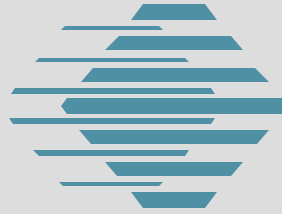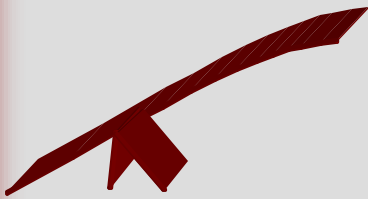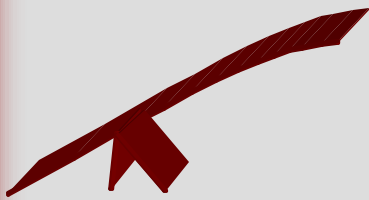
Capability Level 1 - 3
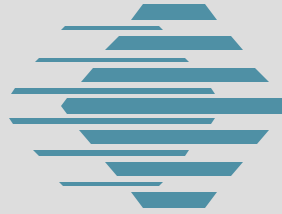
↵ GP 1.2 Perform Basic Activities

≥ Perform the basic activities of the process to develop work products and provide services to achieve the specific goals of the process area

≥ The purpose of this practice is to produce the work products and deliver the services that are expected from performing the process

≥ These activities may be done informally, not following a documented process description or plan

Continuous and Staged Representations

Capability Level 2

↵ Capability Level 2 deals with Managed processes

↵ The managed process achieves the specific objectives such as quality, cost, and schedule

↵ A critical distinction between a performed process and a managed process is the extent to which a process is managed

  ≥ A managed process is planned and the performance of the process is managed against the plan

  ≥ Corrective actions are taken when the actual results and performance deviate significantly from the plan
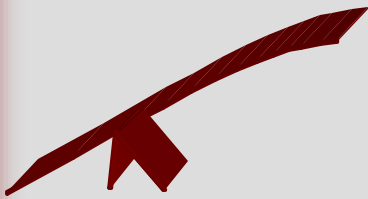
Staged: Commitment to Perform
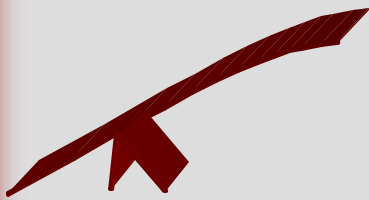
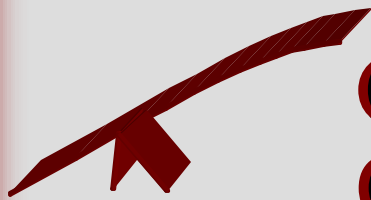# Capability Level 2 Generic Practices

↵ GP 2.1 Establish an Organizational Policy

> ≥ Establish and maintain an organizational policy for planning and performing the process

↵ The purpose of this practice is to define the organizational expectations for the process and make these expectations visible to those in the organization who are affected
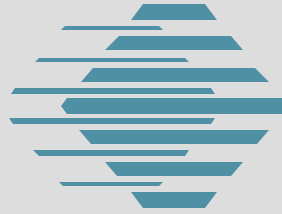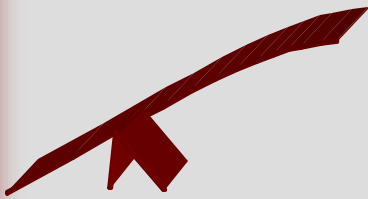
Staged: Ability to Perform
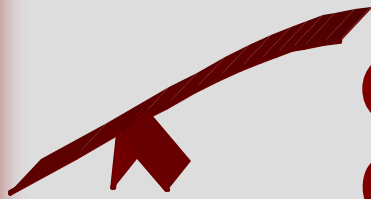
Capability Level 2
Generic Practices - 2

↵ GP 2.2 Plan the Process

≥ Establish and maintain the requirements, objectives, and plan for performing the process

↵ The purpose of this practice is to:

≥ Determine what is needed to perform the process and achieve the established objectives

≥ Prepare a plan for performing the process

≥ Get agreement on the plan from relevant stakeholders

↵ Establishing and maintaining a plan includes documenting it and changing it as necessary

Capability Level 2 Generic Practices - 3
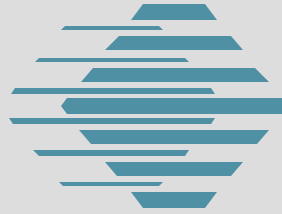
↳ GP 2.3 Provide Resources

≥ Provide adequate resources for performing the planned process, developing the work products, and providing the services of the process

↳ The purpose of this practice is to ensure that the resources needed are available when they are needed

≥ Adequate funding

≥ Appropriate physical facilities

≥ Skilled people or training, mentoring, and coaching to help the existing workforce gain the necessary knowledge and skills

≥ Appropriate tools
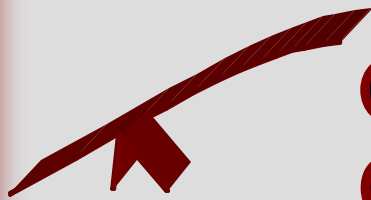
Capability Level 2 Generic Practices - 4

↵ GP 2.4 Assign Responsibility

≥ Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process

↵ The purpose of the practice is to ensure that there is accountability over the life of the process for performing the planned process and achieving the specified results

≥ People assigned must have the appropriate authority

≥ Assignment and authority must be assured over the life of the process
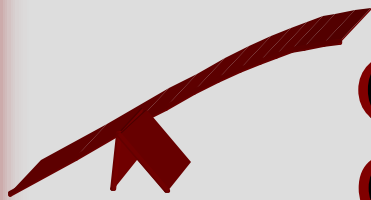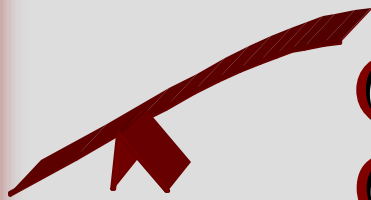
Capability Level 2 Generic Practices - 5
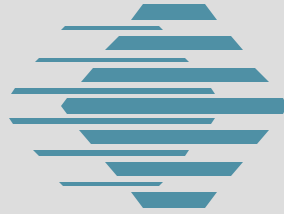
↵ GP 2.5 Train People

≥ Train the people performing or supporting the planned process as needed

↵ Training supports the successful performing of the process by:

≥ Establishing a common understanding of the process

≥ Imparting the knowledge and skills needed to perform the process or support the performing of the process

↵ Overview training should be provided to those who interact with those performing the work
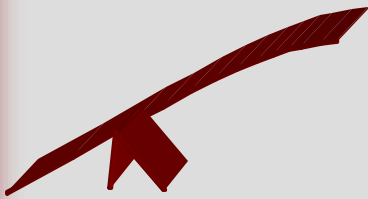
Staged: Directing Implementation

Capability Level 2 Generic Practices - 6

↵ GP 2.6 Manage Configurations

≥ Place designated work products of the process under appropriate levels of configuration management

↵ The purpose of this practice is to establish and maintain the integrity of the work products throughout their useful life

↵ The points in the lifecycle that each "designated" work product will be placed under configuration management must be defined
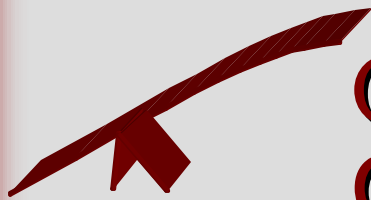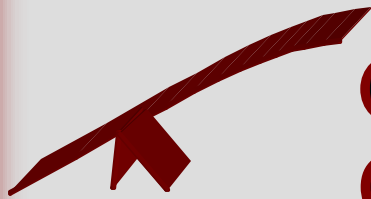
Capability Level 2 Generic Practices - 7

↵ GP 2.7 Identify and Involve Relevant Stakeholders

> ≥ Identify and involve the relevant stakeholders as planned

↵ The purpose of this practice is to establish and maintain the expected involvement of stakeholders during the execution of the process

↵ The objective of planning the stakeholder involvement is to assure that the interactions necessary to the process are accomplished
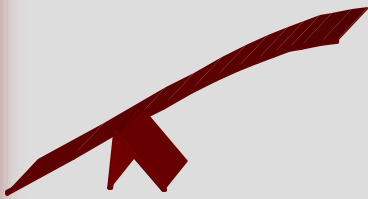
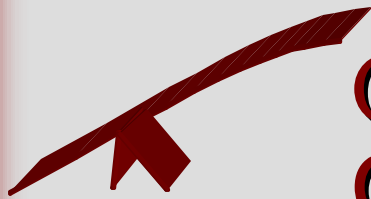# Capability Level 2 Generic Practices - 8

↵ GP 2.8 Monitor and Control the Process

  ≥ Monitor and control the process against the plan and take appropriate corrective action

↵ The purpose of this practice is to perform the direct day-to-day monitoring and controlling of the process implementation

  ≥ Collect and analyze measures of actual performance against the plan

  ≥ Review accomplishments and results of the implemented process against the planned process

  ≥ Identify and evaluate the effects of significant deviations from the planned process

  ≥ Take corrective action when progress differs significantly from the plan and track to closure
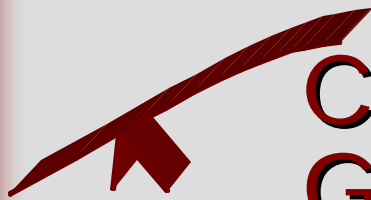
Staged: Verifying Implementation
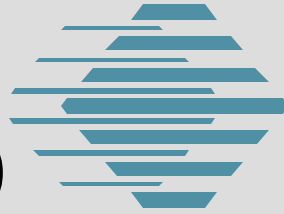
Capability Level 2
Generic Practices - 9
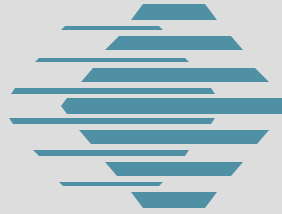
↵ GP 2.9 Objectively Evaluate Adherence

> ≥ Objectively evaluate adherence of the process, and the work products and services of the process to the applicable requirements, objectives, and standards, and address non-compliance
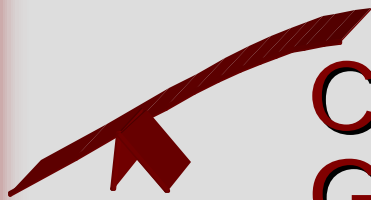
Capability Level 2
Generic Practices - 10

↵ The purpose of this practice is to provide credible assurance that:

- ≥ The process is implemented as planned

- ≥ The planned process satisfies the relevant policies, requirements, standards, and objectives

- ≥ The implemented process satisfies the planned process

- ≥ The results of following the process satisfy their requirements and standards

↵ Evaluation of adherence is typically done by people who are not directly responsible for managing or performing the activities of the process
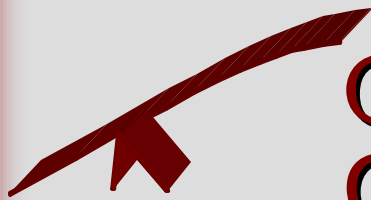
Capability Level 2 Generic Practices - 11

↵ GP 2.10 Review Status with Higher-Level Management

 ≥ Review the activities, status, and results of the process with higher-level management and resolve issues

↵ The purpose of this practice is to provide the higher-level management with the appropriate visibility into the process
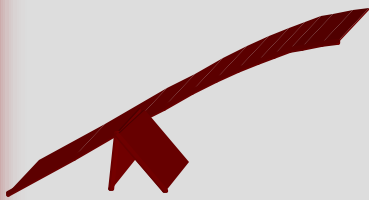
Capability Level 2
Generic Practices - 12

↵ Higher-level management oversight reviews should allow the senior managers to understand:

≥ What processes are being followed on the projects

≥ Are those processes efficient

≥ Are those processes effective

≥ Is following the processes producing the required product quality
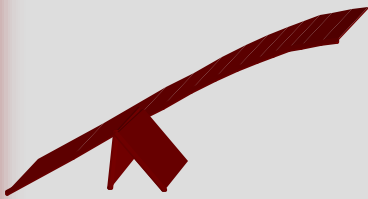
# Continuous and Staged Representation

Capability Level 3

↵ Capability Level 3 deals with Defined processes

↵ A defined process is a managed process that is:

- ≥ **Tailored** from the organization's set of standard processes and related organizational process assets according to the organization's tailoring guidelines

- ≥ Has a maintained process description

- ≥ Contributes work products, measures, and other process improvement information to the organization's process assets
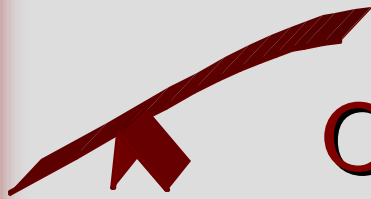
Capability Level 3 - 2

↵ Institutionalization also implies the breadth and depth of implementation of the process and the length of time the process has been in place are appropriate to ensure that it is ingrained as part of the way the work is performed
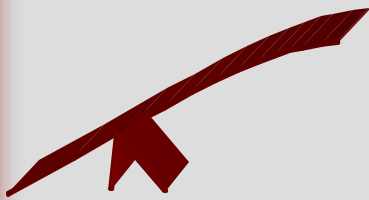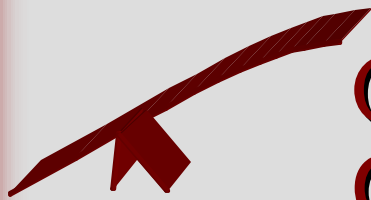
Capability Level 3 Generic Practices

↵ GP 3.1 Establish Defined Process

≥ Establish and maintain the description of the defined process

↵ The purpose of this practice is to establish a description of the process that is tailored from the organization's set of standard processes to address the needs of a specific instantiation

↵ Variability in how the processes are performed across the organization is reduced
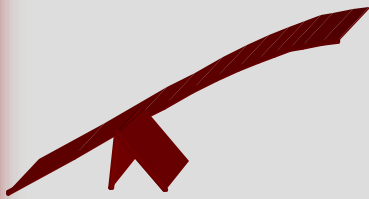
Capability Level 3 Generic Practices - 2

↵ GP 3.2 Collect Improvement Information

≥ Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization's processes and process assets

↵ The purpose of this practice is to collect information and artifacts derived from planning and performing the process and store them in the organizational measurement repository and the organizational library of process-related documentation
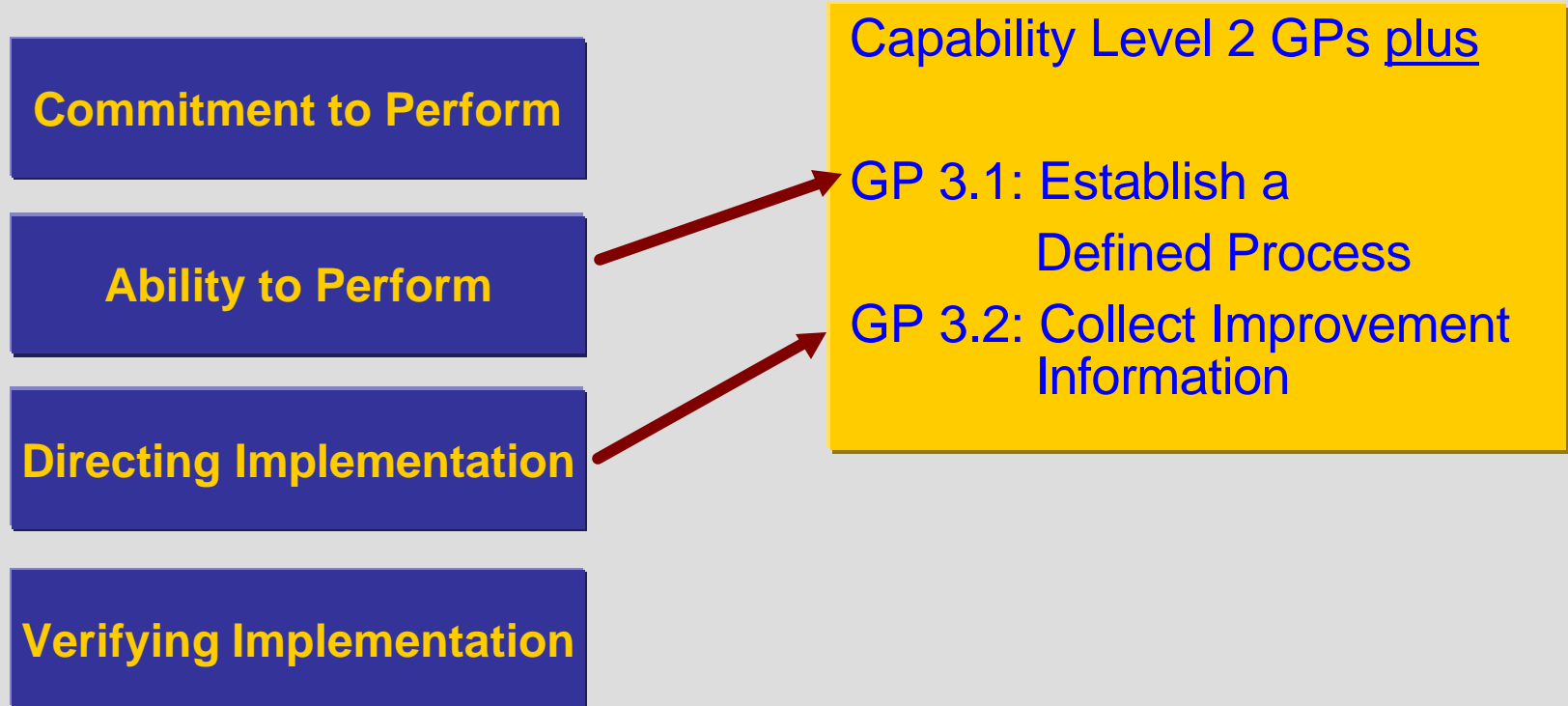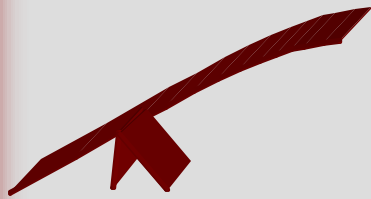
Institutionalization
L 3 Mapping

Staged

Continuous

Commitment to Perform

Ability to Perform

Directing Implementation

Verifying Implementation

Capability Level 2 GPs plus

GP 3.1: Establish a
   Defined Process

GP 3.2: Collect Improvement
   Information

## Defined Level (3)

Institutionalization Generic Practices

GP 2.1:   Establish an Organizational Policy

GP 2.2:   Plan the Process

GP 2.3:   Provide Resources

GP 2.4:   Assign Responsibility

GP 2.5:   Train People

GP 2.6:   Manage Configurations

GP2.7:   Identify and Involve Relevant Stakeholders

GP 2.8:   Monitor and Control the Process

GP 2.9:   Objectively Evaluate Adherence
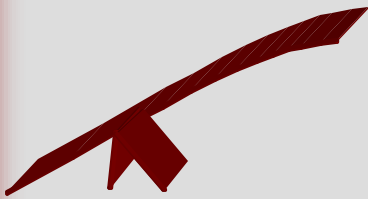
GP 2.10: Review Status with Higher-Level Management

ML 2
CL 2

GP 3.1: Establish a Defined Process

GP 3.2: Collect Improvement Information

ML 3
CL 3
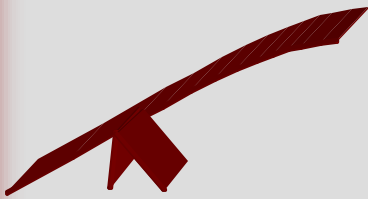
Continuous Representation
(Implicit in the Staged Representation with the Full Implementation of the Process Areas At Maturity Level 4)

Capability Level 4

↵ Capability Level 4 deals with Quantitatively Managed processes

↵ Quantitative objectives for product quality, service quality, and process performance are:

- ≥ Established and used as criteria for managing the process throughout its life

- ≥ Understood in statistical terms

↵ The quantitative objectives are based on:

- ≥ The capability of the organization's set of standard processes

- ≥ The needs of the customer, end users, organization, and process implementers
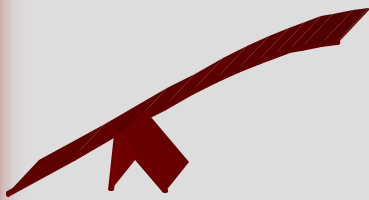
Capability Level 4 Generic Practices

↵ GP 4.1 Establish Quality Objectives

≥ Establish and maintain quantitative objectives for the process about quality and process performance based on customer needs and business objectives

↵ The purpose of this practice is to determine and obtain agreement from relevant stakeholders on specific quantitative objectives for the process about product quality, service quality, and process performance
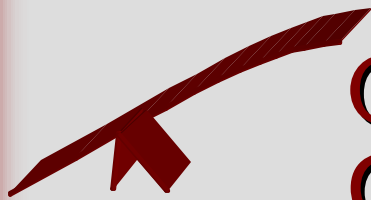
Capability Level 4 Generic Practices - 2

↵ GP 4.2 Stabilize Subprocess Performance

> ≥ Stabilize the performance of one or more subprocesses of the process to determine its ability to achieve the established quantitative quality and process performance objectives

↵ The purpose of this practice is to stabilize the performance of one or more subprocesses of the defined process that are critical contributors to the overall performance using appropriate statistical and other quantitative techniques
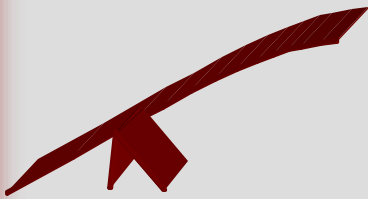
Continuous Representation

(Implicit in the Staged Representation with the Full Implementation of the Process Areas At Maturity Level 5)
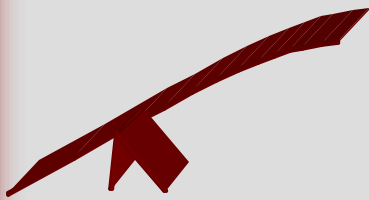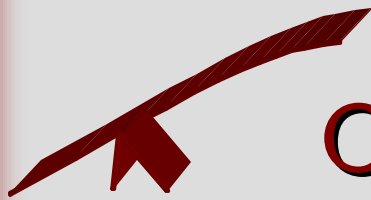
Capability Level 5

↳ Capability Level 5 deals with Optimizing processes

↳ An optimizing process is a quantitatively managed process that is changed to meet relevant current and projected business objectives

↳ An optimizing process focuses on continually improving the process performance through both incremental and innovative technological improvements
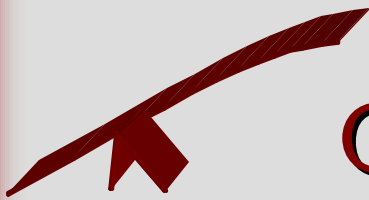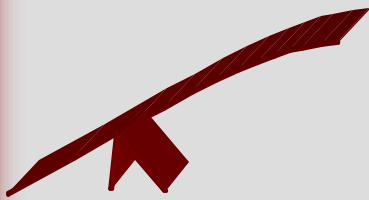
Capability Level 5 - 2

↵ Process improvements are selected based on:

≥ The identification of common causes of process variation

≥ A quantitative understanding of their expected contribution to achieving the organization's process improvement objectives versus the cost and impact to the organization

↵ Process improvements are identified, evaluated, and deployed into the organization in a systematic manner
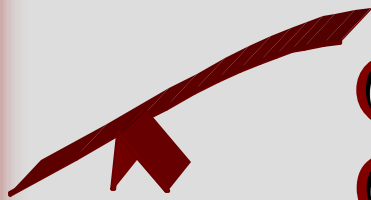
Capability Level 5 - 3

↵ Critical distinction between an optimizing process and a quantitatively managed process

  ≥ Quantitatively managed process is concerned with addressing special causes of process variation and providing statistically predictable results – however these results may not be sufficient to achieve the established objectives

  ≥ An optimizing process addresses common causes of variation and focuses on changing the process to improve process performance in order to achieve the established quantitative process improvement objectives

Capability Level 5 Generic Practices
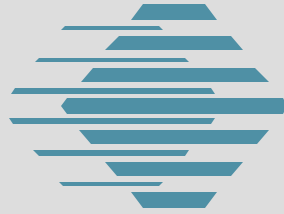
↵ GP 5.1 Ensure Process Improvement Objectives

≥ Ensure continuous improvement of the process in fulfilling the relevant business goals of the organization

↵ The purpose of this practice is to select and systematically deploy process and technology improvements that contribute to meeting established quality and performance objectives for the process

Capability Level 5 Generic Practices - 2

↵ **GP 5.2 Correct Common Causes of Problems**

- ≥ Identify and correct the root causes of defects and other problems in the process

↵ The purpose of this practice is to:

- ≥ Analyze defects and other problems that were encountered

- ≥ Take action to correct the root cause of the defects and other problems that were encountered

- ≥ Prevent these defects and problems from occurring in the future
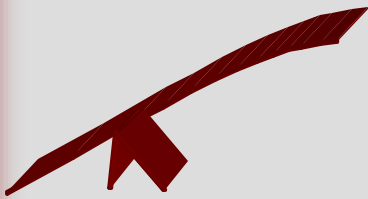
The Process Areas
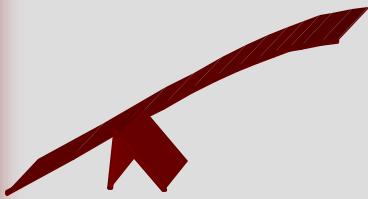
Requirements Management
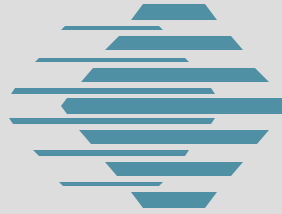
↵ Bi-Directional Traceability is now explicitly asked for in Requirements Management

- ≥ Hard to determine if the delivered product matches the requirements and approved requirements change requests and nothing more without requirements traceability

↵ A requirement is traceable if:

- ≥ You know the source of each requirement
- ≥ Why the requirement exists
- ≥ What requirements are related to it
- ≥ How that requirement relates to other information such as systems designs, implementations, and user documentation
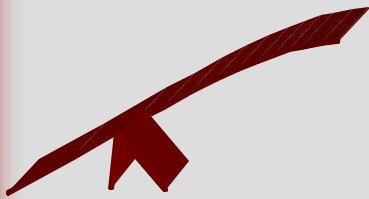
Requirements Management - 2
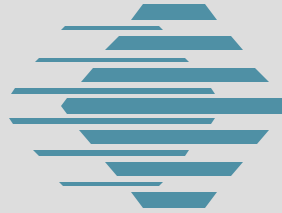
↵ Requirements Management is expected to operate in parallel with Requirements Development and Technical Solution and offer support as new requirements are discovered and requirements change requests are made

The Requirements Management and Requirements Development Partnership

RM

RD

Requirements Development

Requirements Management
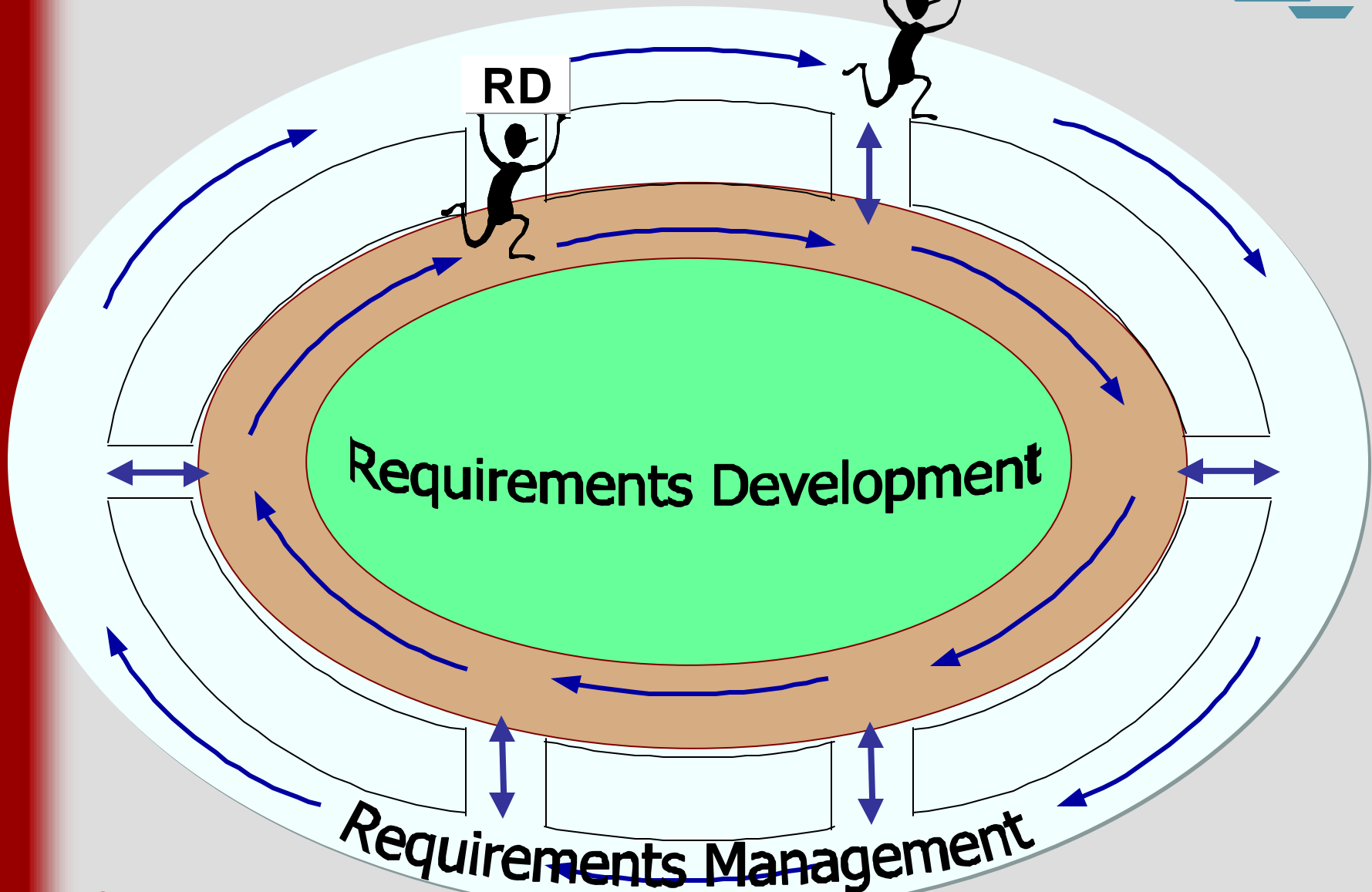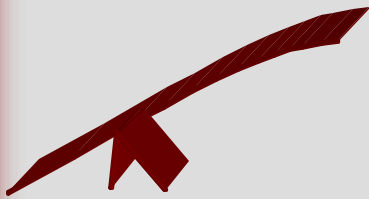
Project Planning

↵ There is a heavier emphasis on having a detailed Work Breakdown Structure

↵ Includes a focus on the project having the necessary Knowledge and Skills to execute the project according to the estimations and plan
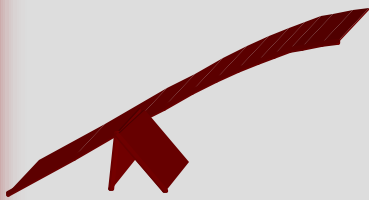
Project Planning - 2

↵ Data Management or the planning and maintaining of project data items and their contents has been added to the list of project management concerns

↵ **Requires** administrative control of project data, both deliverable and non-deliverable

- ≥ Some large, critical projects demand that even Engineering Notebooks with daily entries be placed under control for audit purposes

- ≥ Covers all other forms of data such as CD-ROMs, Disks, Notebooks, etc

- ≥ Part of Project Planning process area
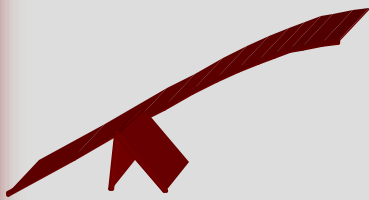
Project Planning - 3

↵ Estimation focuses on size and complexity while effort and cost, and schedule are determined and established respectively based on the size estimation

↵ Estimate size and/or relative difficulty or complexity

↵ Determine the project effort and cost based on the size and complexity estimations

↵ Establish and maintain the project schedule based on the size and complexity estimations
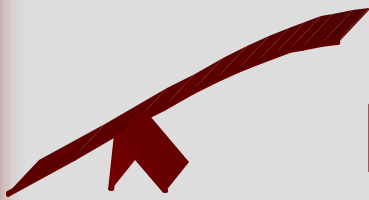
Project Planning - 4

↵ The **identification and involvement of stakeholders** is an important evolution of the "all affected groups" statement that appeared frequently in the SWCMM

↵ The required plan for stakeholder interaction includes:

- ≥ List of all relevant stakeholders

- ≥ Rationale for stakeholder involvement

- ≥ Expected roles and responsibilities

- ≥ Relationships between stakeholders

- ≥ Relative importance of stakeholder to project success by phase

- ≥ Resources needed to ensure relevant stakeholder interaction

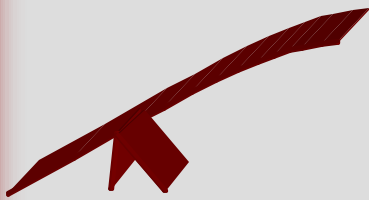- ≥ Schedule for phasing of stakeholder interaction
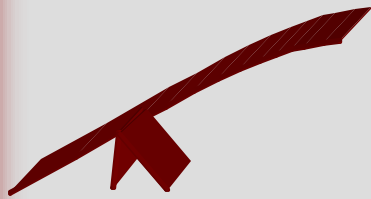
↵ The commitment process is now explicitly defined in Specific Practice 3.3
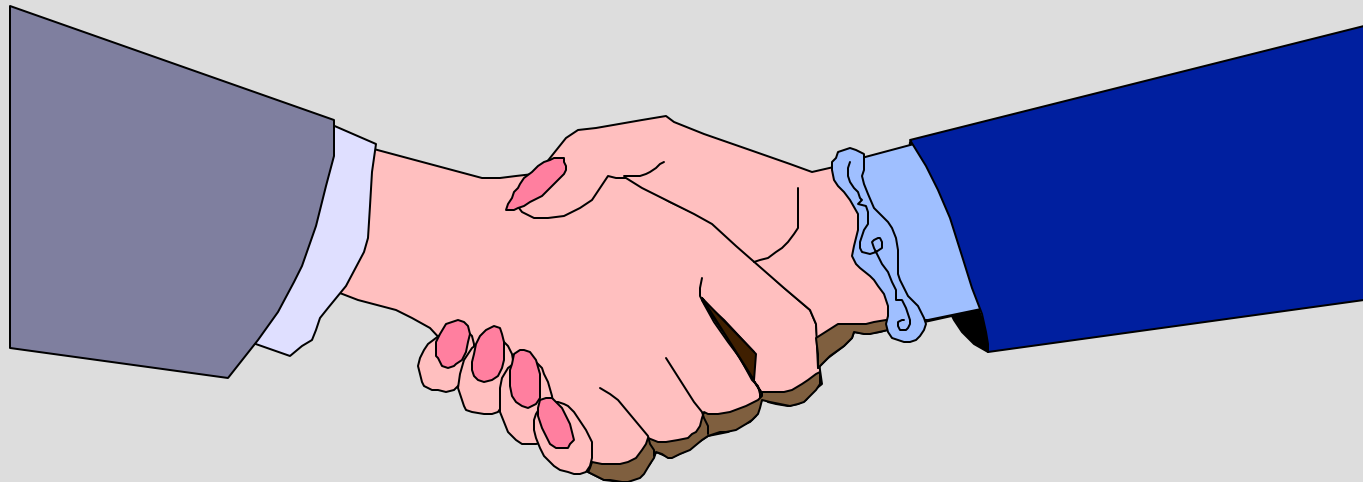
# Project Monitoring and Control

↵ Monitoring Commitments has also been elevated to specific practice level - (SP 1.2)

↵ Monitoring Risks and Stakeholder Involvement is also more strongly emphasized in the CMMI compared to the SWCMM

↵ Monitoring Stakeholder Involvement is explicitly brought out and enables the Generic Practice 2.6 – Identify and Involve Relevant Stakeholders
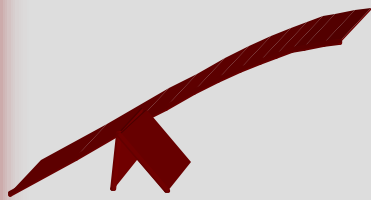
Process and Product Quality Assurance
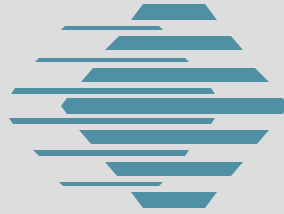
↵ Stresses the **objective evaluation** of products as well as processes!!

↵ Evaluation criteria must be established based on business objectives

- ≥ What will be evaluated?
- ≥ When or how often will a process be evaluated?
- ≥ How will the evaluation be conducted?
- ≥ Who must be involved in the evaluation?
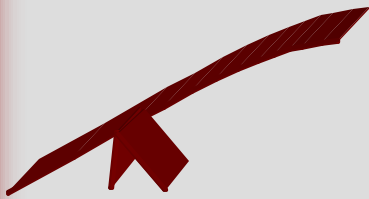
Configuration Management

↵ The idea of "Software Library" has been replaced by the more encompassing "Configuration Management System"

↵ A **configuration management system** includes:

- ≥ The storage media

- ≥ The procedures

- ≥ The tools for accessing the configuration system
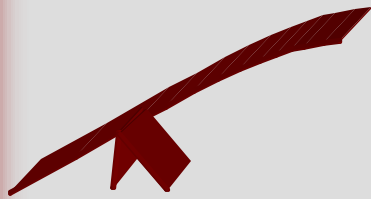
Supplier Agreement Management

↵ Replaces the initial ideas found in Subcontract Management

↵ Now incorporates the original intent of Subcontract Management as well as lessons learned over the past 7 years ☺

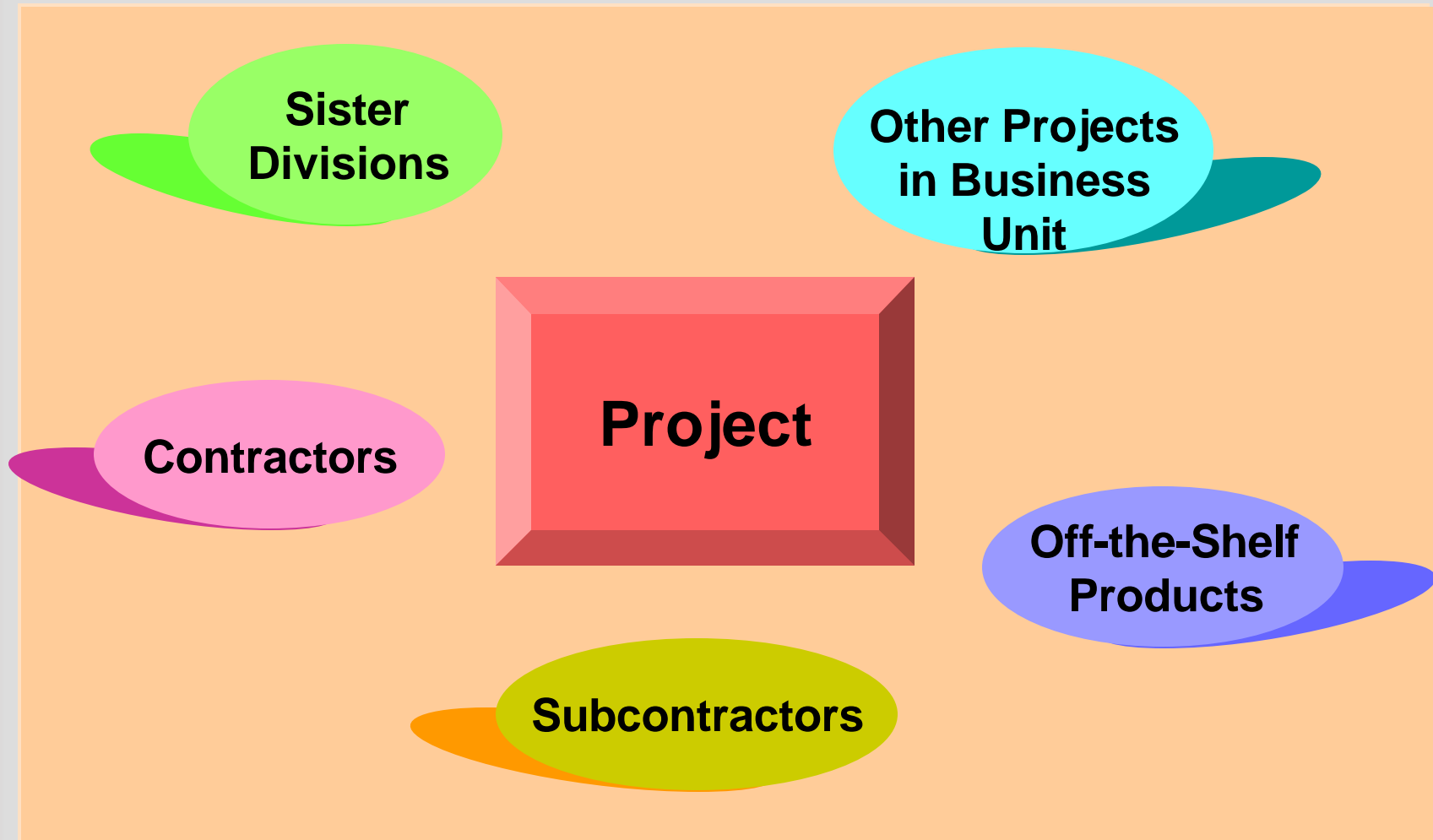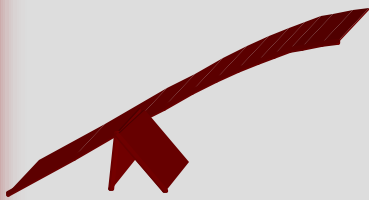# Supplier Agreement Management - 2

Sister Divisions

Other Projects in Business Unit

Project

Contractors

Off-the-Shelf Products

Subcontractors
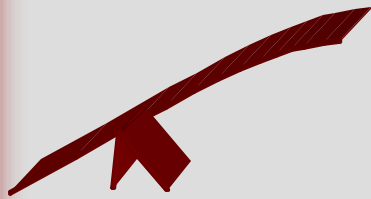
Measurement and Analysis

↵ Provides a description of a measurement initiative that involves the following:

- ≥ Specifying the objectives of measurement and analysis such that they are aligned with established information needs and business objectives

- ≥ Defining the measures to be used, the data collection process, the storage mechanisms, the analysis processes, the reporting processes, and the feedback processes

- ≥ Implementing the collection, storage, analysis, and presentation of the data

- ≥ Providing objective results that can be used in making business judgments and taking appropriate corrective actions
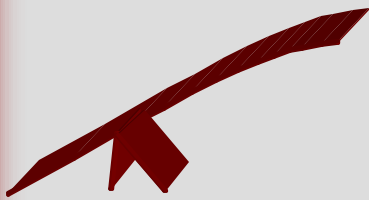
Measurement and Analysis - 2

↵ An organization that barely passes the Measurement and Analysis Common Feature requirements of CMM for Software would not pass the measurement requirements of CMMI

↵ Sets up the organization to evolve its measurement program from basic project management measures to those based on the organization's set of standard processes to statistical control of selected subprocesses according to the organization's business needs
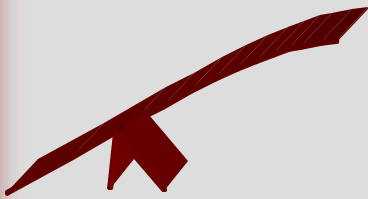
Requirements Development

↵ The concepts presented in Requirements Development are consistent with very modern publications on Requirements Engineering

↵ Clearly defines the need for identification and care of **stakeholders**

↵ Incorporates the interface ideas of Systems Engineering and Software Engineering with regards to gathering, analyzing, documenting, and maintaining requirements found in CMM for Software v1.1 and expands on them
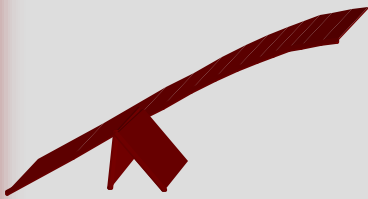
Requirements Development - 2

↵ Requirements Development together with Technical Solution truly shows the recursive and iterative nature of developing requirements:

Stakeholder Needs

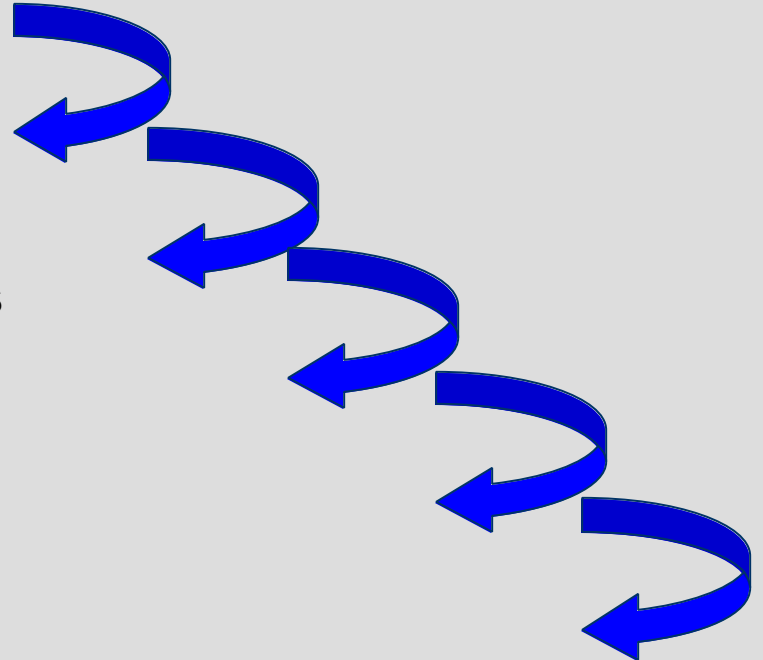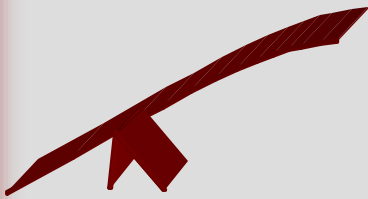**Customer Requirements**

Product and Product Component Requirements
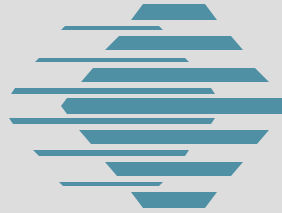
Requirements Analysis

Derived Requirements

Allocation to Product Functions and Product Components including Objects, People, and associated Processes or People

Requirements Development - 3

↵ The Requirements Development PA includes a description of developing an operational concept and operational scenarios to refine and discover new requirements, needs, and constraints that include the interaction of the product, the end user and the environment

↵ It also includes a strong focus on **interface** requirements

↵ It suggests the use of models, simulations, and prototyping to perform risk assessments to reduce the cost and risk of product development

↵ It is very tightly coupled to the Technical Solution process area
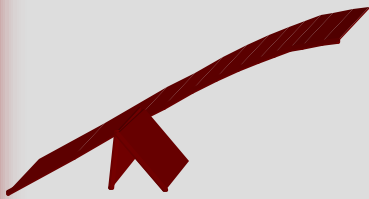
Requirements Development - 4

↵ It emphasizes the idea of starting the process of **requirements validation** very early in the product lifecycle
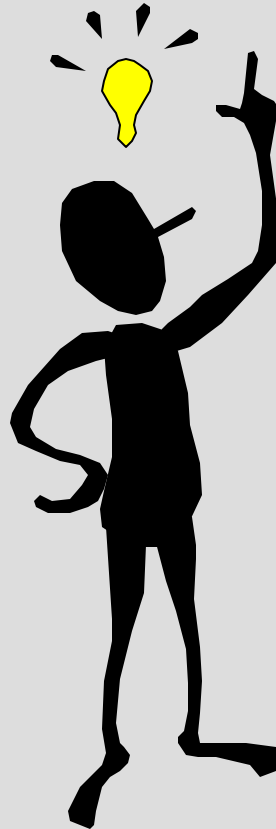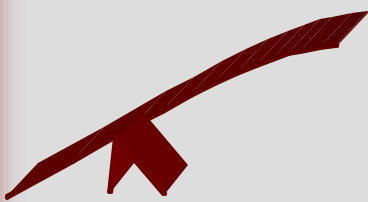
Spiral Model of the Product Requirements Engineering Process

Informal statement of requirements

Decision point: accept document or re-enter spiral

Requirements elicitation

Requirements analysis and negotiation

START

Requirements document and validation report

Agreed requirements

Requirements validation

Requirements documentation

Gerald Kotonya and Ian Sommerville,
<u>Requirements Engineering</u>, John Wiley and Sons, 1998

Draft Requirements document

Technical Solution

↵ Technical Solution practices apply not only to the product and product components but also to services and product-related processes

↵ Technical Solutions are presented as being developed **interactively** with product or product component requirements definition

↵ Technical Solution stresses the need for developing **alternative** solutions
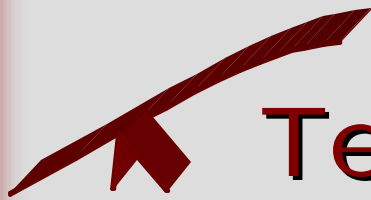
Technical Solution - 2

↵ Quality Factors (e.g., maintainability, expandability, reliability) were discussed in the CMM/SW Level 4 KPA Software Quality Management – "Quality goals for the project's software products are defined, monitored, and revised throughout the software lifecycle"

↵ CMMI discusses the quality factors first in Requirements Development and emphasizes their importance in Technical Solution
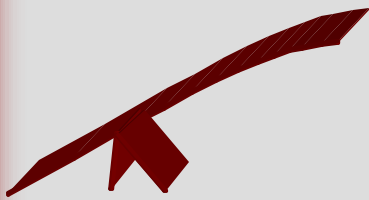
Product Integration

↵ Product Integration presents the concepts to achieve complete product integration through progressive assembly of product components, in one stage or in incremental stages, according to a defined integration strategy

↵ It stresses the careful analysis and selection of the optimum integration strategy

≥ The basis for effective product integration is an integration strategy that uses combinations of techniques in an incremental manner
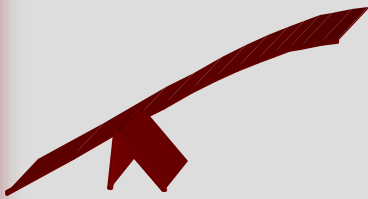
Product Integration - 2

↵ It points out the need to establish and maintain the **environment** required to support the integration of the product components

↵ It introduces the concept of product component and product assembly **Checkout,** to evaluate its performance and suitability

↵ It presents the idea of applying (Product Integration, Verification, and Validation) in successive triplets until the product is ready for packaging and delivery
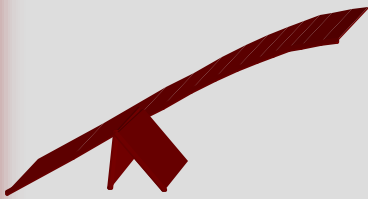
Product Integration - 3

↵ It stresses the effective management of all interfaces to ensure that all interfaces will be complete and compatible

≥ Interface descriptions

≥ Interface data

↵ Packaging and Delivery is specifically called out in Specific Practice 3.4 – an improvement over the information provided in the SWCMM

↵ Inspecting Product Elements Upon Receipt is an activity that is not well done in the industry today and deserves the attention that is now defined in the CMMI!
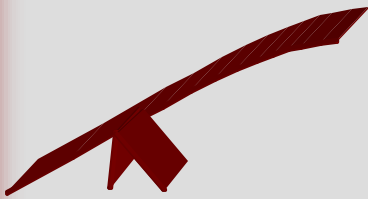
Verification

↵ Verification is used to assure that selected work products meet their specified requirements

↵ Verification assures "You built it right"

↵ Expects a verification strategy that addresses the specific actions, resources, and environments that will be required for work product verification to be developed

≥ Developed concurrently and iteratively with the product and product component designs
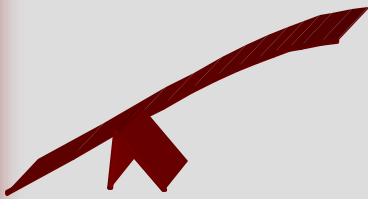
# Verification - 2

↵Captures the ideas of using:
- ≥Peer Reviews
- ≥Load, stress and performance testing
- ≥Functional decomposition based testing
- ≥Simulation
- ≥Prototypes
- ≥Observations and demonstrations
- ≥Operational scenario testing

as they apply to ensuring that the requirements are being addressed at each phase of the development lifecycle from a systems, and software point of view
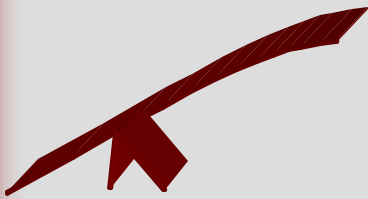
Validation

↵ Validation is used to demonstrate that a product or product component fulfills its intended use when placed in its intended operational environment

↵ Validation assures "You built the right thing"
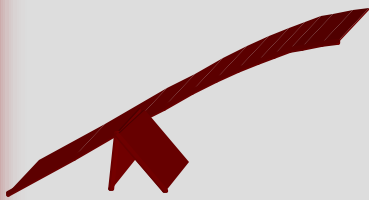
Risk Management

↵ The concepts inherent to Risk Management finally made it to Process Area status

  ≥ Risk Identification

  ≥ Risk Assessment

  ≥ Risk Analysis

  ≥ Risk Prioritization

  ≥ Risk Mitigation

  ≥ Risk Contingency Planning

↵ The ideas behind Risk Contingency Planning and Risk Mitigation have been merged but are definitely clearer
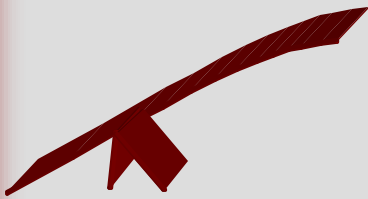
Decision and Analysis

↵ Decision and Analysis helps determine which issues should be examined by formal decision analysis

↵ Decision and Analysis presents the concepts of **identifying** alternatives to issues that have a significant impact on meeting objectives, **analyzing** the alternatives, and **selecting** one or more alternatives that best support prescribed objectives

↵ Decision and Analysis is a new concept for the software world whose time has certainly come
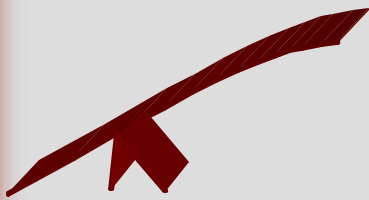
Organizational Process Definition

↵ The wording for this process area has changed subtly but significantly from that of the SWCMM

   ≥ Establish and maintain a **usable set** of organizational process assets including the organization's set of standard processes

   ≥ Acknowledges that an organization may utilize more than one standard process to handle its product lines and business needs

↵ Process Database evolved into **Organizational Measurement Repository**
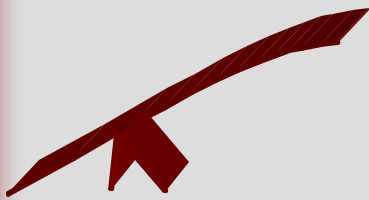
Integrated Project Management

↵ Integrated Project Management takes on the aspects of Integrated Software Management and Intergroup Coordination that were found in the SWCMM

≥ The project is conducted using a defined process that is tailored from the organization's set of standard processes

↵ It also emphasizes the need to proactively integrate the concepts in the Project Plan and all supporting plans such as:

≥ Quality assurance plans

≥ Configuration management plans

≥ Risk management strategy

≥ Verification strategy

≥ Validation strategy

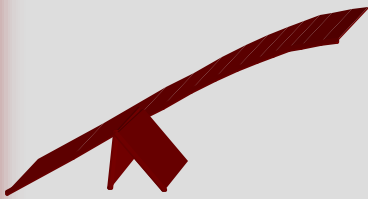≥ Product integration plans
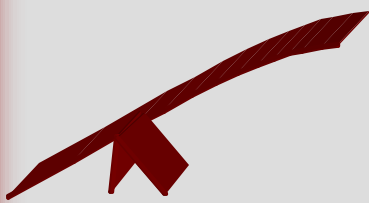
Organizational Process Performance

↵ The Organizational Process Performance process area was developed to help organizations set the stage for quantitative process management:

≥ Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained
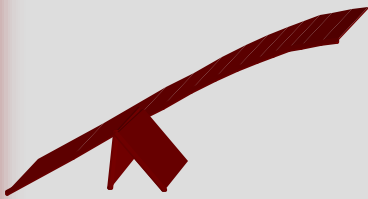
Performance Baselines

↵ The organization's process performance baselines measure performance for the organization's set of standard processes at various levels including:

≥ Individual processes (e.g., test case inspection element)

≥ Sequence of connected processes

≥ Processes for the complete lifecycle

≥ Processes for developing individual work products

Performance Baselines - 2

↵ There may be several process performance baselines to characterize performance for subgroups of the organization – Examples include:

≥ Product Line

≥ Application domain

≥ Complexity

≥ Team size

≥ Work product size
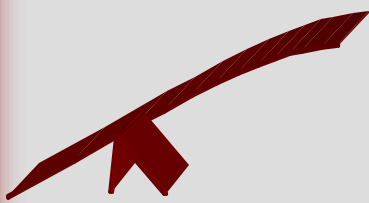
Quantitative Project Management

↵ This Process Area combines the concepts of Quantitative Process Management and Software Quality Management from the SWCMM point of view

↵ The concepts of quantitative management and statistical process control are strongly present in this process area.

↵ Quantitative Project Management is tightly coupled with Organizational Process Performance, taking standard process measures from it to achieve stability of subprocesses and providing information back to it once the statistical control boundaries are established
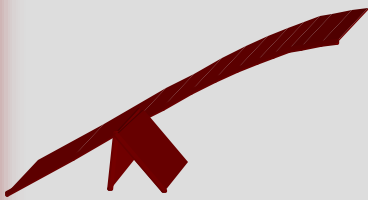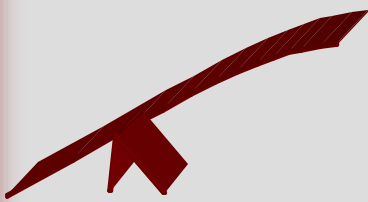
Quantitative Management Concepts

↵ Quantitative Management is tied to the organization's strategic goals for product quality, service quality, and process performance

↵ When higher degrees of quality and performance are demanded, the organization and projects must determine if they have the ability to improve the necessary processes to satisfy the increased demands
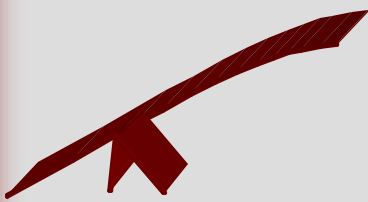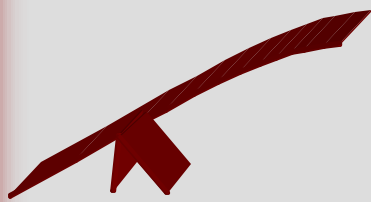
Quantitative Management Concepts - 2

↵ Achieving the necessary quality and process performance objectives requires stabilizing the processes that contribute most to the achievement of those objectives

≥ Reducing process variation is an important aspect to quantitative management:

↑ It is important to focus on subprocesses that can be controlled to achieve a predictable performance

↵ Assuming the technical requirements can be met, the next decision is to determine if it is cost effective

Quantitative Management Concepts - 3

↳ Successful application of Quantitative Management concepts must look closely to:

  ≥ The business demands

  ≥ The capability of existing processes

  ≥ The ability of the organization to bring processes and **subprocesses** under statistical control in a cost effective manner

↳ Statistical process control is often better focused on organizational areas such as Product Lines where there is high similarity of processes, than on the organization's entire set of products

# Quantitative Project Management Concepts References

↵ Some sources that can help to really understand what is behind this Process Area are:

> ≥ <u>Measuring the Software Process</u> by William Florac and Anita Carleton.

> ≥ <u>Statistical Methods for Software Quality</u> by Adrian Burr and Mal Owen

> ≥ <u>Understanding Variation</u> by Donald Wheeler
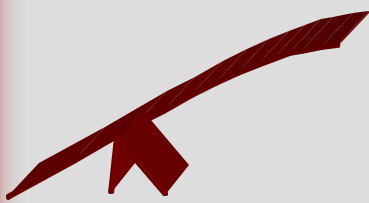
Organizational Innovation and Deployment

↵ Combined Process Change Management and Technology Change Management from the SWCMM point of view

↵ Just Do It! – Or once one has the innovation ideas identified and analyzed against the organization's business objectives and cost measures, get it tried and expanded wherever possible throughout the organization

↵ Subpractices are excellent and provide a solid picture of what is required for this process area
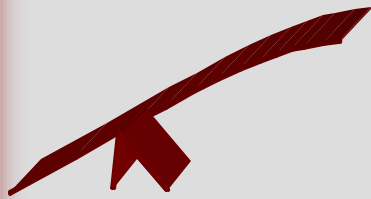
Organizational Innovation and Deployment Overview

↵ The Organizational Innovation and Deployment process area suggests the selection and deployment of incremental and innovative technological improvements that can improve the organization's ability to meet its quality and process performance objectives

Organizational Innovation and Deployment Overview - 2

↵ Process and technology improvements that will be deployed are selected from proposals based on the following criteria:

≥ A quantitative understanding of the organization's current quality and process performance

≥ Estimates of the improvement resulting from the deployment

≥ The resources and funding available for that deployment

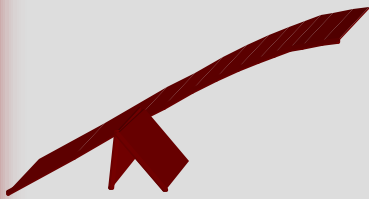≥ The expected benefits weighed against the cost and impact to the organization
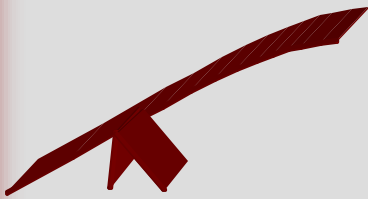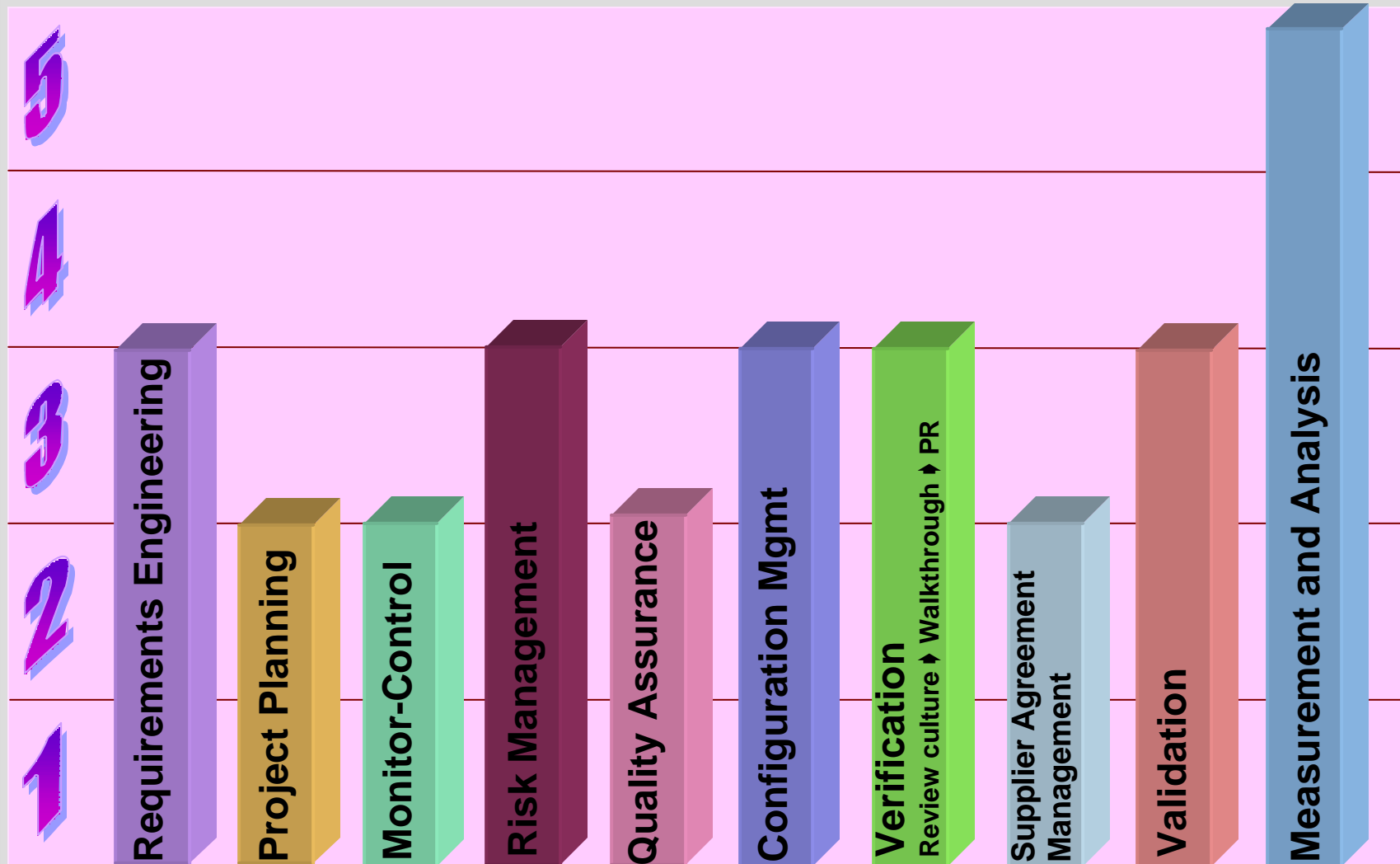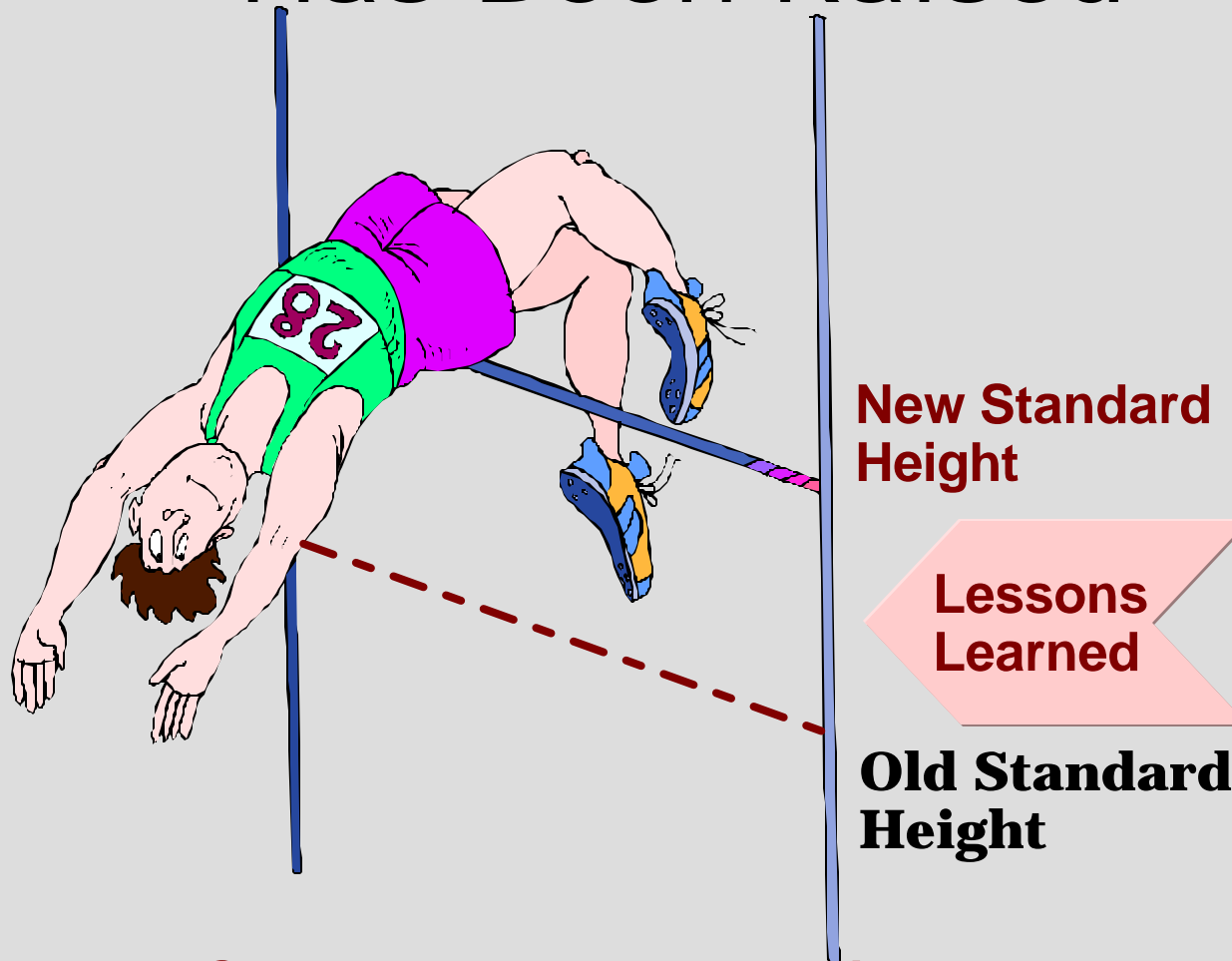
Constageduous Viewpoint
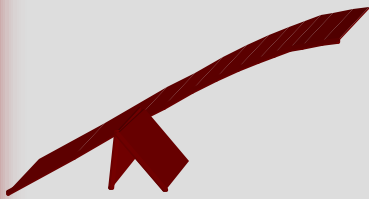
Constageduous Viewpoint

↵ CMMI Framework provides the opportunity to apply the principles of both the staged and continuous representations in a process improvement oriented manner or a manner that might be labeled "Constageduous"

Constageduous Viewpoint - 2

5

4

3

2

1

Requirements Engineering

Project Planning

Monitor-Control

Risk Management

Quality Assurance

Configuration Mgmt

Verification
Review culture ♦ Walkthrough ♦ PR

Supplier Agreement Management

Validation

Measurement and Analysis

The Standard Bar Has Been Raised

New Standard Height

Lessons Learned

Old Standard Height

The Standard Bar has been raised – Lessons learned over the past 7 years have now been incorporated into this integrated CMM
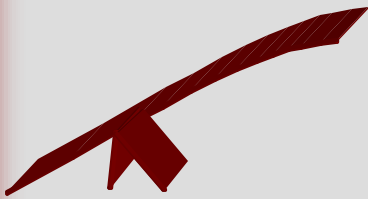
Tim Kasse
Kasse Initiatives LLC

30 West Sheffield Avenue
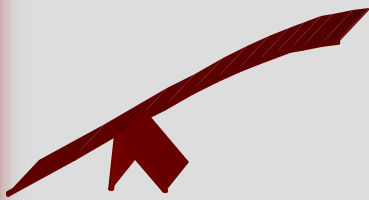Gilbert, Arizona 85233
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E-mail: kassetc@aol.com
Web Site: www.kasseinitiatives.com

For More Information About CMMI

↵ Go to CMMI Website

≥ http://www.sei.cmu.edu/cmmi

≥ http://www.sei.cmu.edu/cmmi/products/public-release.html

↵ Contact SEI Customer Relations

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